

ANNALS of SURGERY

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CONTENTS

SYPHILIS AND SURGERY.....	321
GEORGE GELLHORN, M.D.....	St. Louis, Mo.
SURGICAL TECHNIC.....	328
WALTER G. ELMER, M.D.....	PHILADELPHIA, PA.
TRAUMATIC FACIAL PARALYSIS AND ITS SURGICAL TREATMENT BY FREE TRANSPLANTATION OF FASCIA LATA.....	334
HERMANN FISCHER, M.D.....	New York, N. Y.
WHEN AND WHEN NOT TO OPEN THE ABDOMEN IN ACUTE SURGICAL CONDI- TIONS.....	340
JOHN B. DEEVER, M.D.....	PHILADELPHIA, PA.
✓ THE TREATMENT OF INTESTINAL OBSTRUCTION.....	354
THOMAS G. ORR, M.D., AND RUSSELL L. HADEN, M.D.....	KANSAS CITY, KANSAS
AN ANATOMICAL AND CLINICAL STUDY OF INFECTIONS OF THE HAND.....	359
R. RUSSELL BEST, M.D.....	OMAHA, NEBR.
STRICTURE OF THE MALE URETHRA.....	379
MEREDITH F. CAMPBELL, M.D.....	New York, N. Y.
URETHRAL STONES.....	400
RALPH M. LeCOMTE, M.D.....	WASHINGTON, D. C.
EXTRAARTICULAR ARTHRODESIS OF THE HIP FOR TUBERCULOSIS.....	404
FRED. H. ALBEE, M.D.....	New York, N. Y.
ASTRAGALO-SCAPHOID DISLOCATION.....	427
HENRY MULCH, M.D.....	New York, N. Y.
ASTRAGALECTOMY FOR FRACTURES OF THE ASTRAGALUS.....	435
WILLIAM TATE GRAHAM, M.D., AND DONALD M. FAULKNER, M.D.....	RICHMOND, VA.
ACUTE FRACTURE-DISLOCATIONS ABOUT THE ANKLE JOINT.....	439
H. EARLE CONWELL, M.D.....	BIRMINGHAM, ALA.
TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY.....	454
STATED MEETING HELD NOVEMBER 14, 1928.	
TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY.....	465
STATED MEETING HELD DECEMBER 3, 1928.	
BRIEF COMMUNICATIONS: <i>Van Wagenen</i> : Brain Abscess Spatula. <i>Kirby</i> : Volvulus of the Cæcum.....	474
BOOK REVIEWS: <i>Walton</i> : A Text-book of Surgical Diagnosis. <i>Young and Waters</i> : Urological Röntgenology. <i>Keyes</i> : Urology. <i>Eisendrath</i> : Text-book of Urology.....	477

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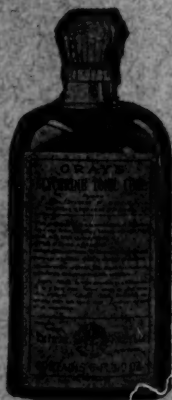
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ANNALS *of* SURGERY

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SYPHILIS AND SURGERY

BY GEORGE GELLHORN, M.D.

St. Louis, Mo.

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THERE are so many syphilitics in the world that we are bound to encounter a certain proportion of them among the patients on whom we are about to operate. Coues⁷ estimates this percentage as high as eighteen. Have they as fair a chance of recovery as nonsyphilitics? Are they "poor surgical risks"? Must we expect definite complications and take special precautions? Does their disease alter the general aspect of the case as far as diagnosis and indication for operation are concerned? All these are questions which a thoughtful surgeon will put to himself.

In trying to formulate an answer I find it impossible to limit myself altogether to gynecology, simply because the subject has thus far attracted too little attention in my own specialty. Moreover, the problem affects any surgeon, no matter what his special line of work happens to be.

Two ways by which surgical patients may come to harm on account of their syphilis immediately suggest themselves to us.

1. Through errors in diagnosis such patients may be subjected to unnecessary and even dangerous operations. That mistakes of this kind occur is, after all, not surprising. A disease like syphilis, which appears in a thousand-fold deceitful disguises, might well produce manifestations which resemble conditions calling for operative intervention; and indeed there is hardly a surgical affection of any part of the body that at one time or another has not been mimicked by syphilis.

Nuzum²² collected a long list of needless surgical operations from failure to recognize tabes. In one instance the patient had five laparotomies, the last three for post-operative adhesions; and following each operation the old symptom of epigastric pain, with severe vomiting, returned—that is, the gastric crisis of tabes.

In 200 cases of osseous syphilis under the observation of Stokes²³ the proportion of surgical error reached 21 per cent. "Osteosarcomas" that in reality were syphilitic manifestations have many times been treated surgically (Lustgarten, Fordyce, and others); and there is one case on record where an arm was amputated in a boy of nine because of such a diagnostic error.

Sheeley²⁴ mentions several cases of gumma in testicles removed with the wrong diagnosis of malignancy or tuberculosis.

Gaucher²⁵ speaks of a case of amputation of the penis with excision of both inguinal glands for a supposed cancer which in reality was a chancre; and Mewborn,²¹ writing in the pre-Wassermann days, records a similar case which is instructive because of the mistake in diagnosis and the fact that the therapeutic test with mercurial inunctions, mixed

treatment, etc., was used, but not in sufficient dosage to yield results. The man presented the initial lesion on the penis but no secondaries. One year later amputation of penis for "carcinoma" and removal of inguinal glands. Ten years later, V-shaped excision of "epithelioma" of lower jaw. Since then secondaries in various parts of the body. Cure following energetic antisyphilitic treatment.

In the case reported by Fabian⁹ an ovarian tumor had been removed by operation with the diagnosis of sarcoma. Five years later "metastases" appeared below the left costal arch. As the Wassermann was strongly positive, atoxyl treatment was given which brought about the complete disappearance of the tumor. In the retrospect it is clear that the metastasis as well as the original ovarian tumor were gummata, not sarcomatous, and would have required no operation.

I¹⁰ have reported a case where, even after the abdomen was opened, I diagnosed an inoperable cancer of the liver until the course of convalescence made me change my diagnosis to one of gumma and enabled me to cure the patient permanently by antisyphilitic treatment.

Instances of chancre or gumma of the cervix uterus, wrongly diagnosed as cancer, have been recorded in the international literature so frequently that I have devoted a separate paper to this subject.*

As to uterine hæmorrhages, I refer to Mouchotte,²² who performed hysterectomy on a young woman because he failed to recognize in time the syphilitic nature of her metrorrhagia. Among the cases of backache reported by Roberts,²⁷ there was one of operation for uterine displacement, but the symptom which had been caused by syphilitic myositis did not clear up until mixed treatment was given. In the case of Joltrain¹⁸ a woman of twenty-seven was operated on with the diagnosis: appendicitis or salpingitis, and the appendix was removed. After a short post-operative improvement the old gastro-intestinal symptoms returned in a greatly aggravated form. The difficulty of interpreting these symptoms and the history of a miscarriage early in married life led to taking a Wassermann, which was positive. The spinal fluid likewise gave a positive reaction and, moreover, showed a marked lympho-cytosis which, according to Widai and Ravant, is typical of secondary syphilis. Energetic intravenous treatment completely relieved all symptoms within twelve days.

Stein and Hensel³¹ operated upon a woman of sixty-four with a negative blood Wassermann for a large intra-abdominal tumor supposed to be either an ovarian cyst, a pedunculated fibroid or a cyst of the omentum. At laparotomy the abdominal cavity was found empty, and the tumor was discovered to be a gumma of the abdominal wall with beginning suppuration. After operation the pathological behavior of the reflexes and the strongly positive Wassermann of the spinal fluid led to the diagnosis of tabes. Under energetic antisyphilitic treatment, the tumor disappeared within two months. The authors quote three similar cases from the literature.

Recasens²⁰ performed a vaginal hysterectomy suspecting cancer of the body of the uterus. The specimen, however, exhibited only a fungous thickening of the endometrium with numerous small scars. Microscopically, there were extensive perivascular infiltrations and endo-arteritic proliferations which in places had caused a complete obliteration of the blood vessels. The scars in the uterine mucosa were interpreted by the author as healed syphilitic ulcers. This, by the way, is one of the few cases of syphilitic endometritis recorded in literature.

If the Wassermann or kindred test as a routine pre-operative measure becomes the standard in our hospitals, the number of such mistakes is bound to decrease, and it will depend on the critical judgment of the surgeon to establish a clear-cut indication for operative intervention. In doubtful cases, a course of specific treatment may clear up the situation.

* Amer. Journ. of Syphilis, January, 1929.

SYPHILIS AND SURGERY

2. The number of patients with unrecognized or untreated syphilis who are subjected to operation on very good surgical indications is probably very large. Do they run any undue risk in surgery? Is their syphilis likely to lessen their chances of ultimate recovery or to interfere with the normal course of convalescence?

Theoretically an affirmative answer to the questions seems self-evident. We know that syphilitic infection causes a generalized spirillosis almost instantaneously. Senger³¹ tells of the deliberate inoculation of a medical student. Nine hours afterward the lesion was carefully removed by wide dissection. Nevertheless the patient showed typical syphilis later, proving that the increase of spirochaetes is tremendous and their spread through blood and lymph channels marvelously rapid.

The problem has also been studied experimentally by Brown and Pierce⁵ who showed that, in rabbits, as soon as infection takes place, the spirochaetes begin to multiply and invade the surrounding tissues, gaining access to both the lymphatics and the blood stream, and are widely distributed over the body even before an initial lesion can be detected.

We know, furthermore, through the researches of Warthin,³⁵ Barach,³ Henry,¹⁴ and others, that in syphilis the blood channels and the heart suffer the greatest involvement and that the heart is probably the most frequently affected organ of the body. We learn from Hoppe-Seyler¹⁵ that syphilitic lesions of the aorta and other vessels seldom retrogress completely under specific treatment, and we are warned not to subject such patients to physical strain. Here one may again refer to Warthin,³⁵ who reports eight cases of sudden death due to an exacerbation of latent syphilitic myocarditis which was caused by overexertion and heat. Only in two of these eight cases was the disease recognized in life; and the relation these observations bear to the physical strain of a major operation is self-evident.

Of other vital organs, the kidneys may become acutely (Stokes²⁰) or chronically (Hoppe-Seyler¹⁵) inflamed in syphilis. In fact, all organs and tissues of the body may be more or less affected by the disease; and the syphilitic cachexia with its resulting lack of general resistance, which we find so frequently, and more particularly in women, is by no means confined to the later stages of the disease, but is often encountered, for reasons as yet unknown, in young women who have latent syphilis.

The life insurance companies have long realized that syphilis lowers the vitality of individuals. "No man," says one of their experts (Brockbank⁴), "who has ever had syphilis can be rated as a first-class life. The mere fact of his having had syphilis at once places him in a second-class division."

Clinical evidence in the field of surgery amply confirms this attitude. In forty-one surgical cases with positive Wassermanns, Senger³¹ observed non-union of fractures, gall-bladder infection associated with cirrhosis of the liver, intestinal strictures resembling cancer, etc. Repeatedly, there was disturbance in wound healing, as for instance after an operation for uterine fibroid, where no one had suspected the patient of syphilis until a gumma

developed along the line of incision. "Had the Wassermann been taken before instead of after the operation, how much suffering she would have been spared."

Similar observations are rapidly accumulating in recent literature. Coues⁷ calls attention to the fact that the operative wound may take on the characteristics of a specific ulceration. Darnall,⁸ Mendonça,¹⁹ Ritch,²⁶ and others have observed cases in which the entire wound opened up again after as many as ten days, without any signs of infection, but healed perfectly without further mishaps after specific treatment had been instituted. Payne²⁴ concludes that "the surgeon can do no greater work for the industries he represents than have a Wassermann made on *all* injured patients, so that he can institute appropriate treatment to the end that the injured, the employer, and the doctor will not have a long-drawn-out treatment and convalescence".

My own observations¹² coincide closely with those quoted above. I have seen extensive suppurations of the abdominal incision resist all possible treatments for weeks, but turn into clean and vigorously granulating wounds as if by magic when antiluetic treatment was instituted. I recall five cases in which the entire abdominal incision broke open about a week after operation. The tissues of the abdominal wall showed no tendency whatever to unite, but there was no suppuration present. All five patients were profoundly cachectic. Two were probably not luetic, but two were frank syphilitics, and the fifth, despite a negative Wassermann, was most likely diseased.

In addition to increased morbidity, there may also be an increased operative mortality in syphilitic patients. To express the percentage in figures is probably impossible. The case related by Carstens⁶ may serve as a suggestion. A patient with a large fibroid received antisymphilitic treatment preparatory to operation. A few days before the latter was to be performed she died quite suddenly from cerebral hæmorrhage as the autopsy revealed. Had this woman died after operation, her death would probably not have been ascribed to her syphilis. And yet I am convinced that in two cases of mine of death from surgical shock in Wassermann-test women, it was the patients' syphilis, and not the operation, which, in the last analysis, caused the fatal issue. In one of these women, in whom a vulvectomy for very extensive elephantastic tertiary vegetations was performed, the bleeding, which as in the cases reported by Gallagher,¹⁰ was excessive, may have been as harmful as was the narcosis.

Here, too, the case of a man of forty-one may be mentioned who was operated upon by Ritch²⁶ for acute suppurative appendicitis. His post-operative course was not remarkable until the seventh day when he developed a condition which was at first diagnosed as cerebral hæmorrhage with hemiplegia. A thorough physical examination was now made, and the strongly positive outcome of the Wassermann test led to the diagnosis of cerebral endarteritis of syphilitic origin, and specific treatment brought about a cure.

That a general anæsthesia with syphilis of the brain may prove fatal has been conclusively demonstrated in two cases by Le Count and Singer.¹⁷

SYPHILIS AND SURGERY

The post-mortem study of the brains showed typically syphilitic histological changes. In one case the operation was commonplace, the length of the narcosis barely one hour; but investigation following death disclosed the fact that the patient had complained of severe continuous headaches for the past few years. The authors therefore demand that with symptoms or signs suggestive of alterations of any sort in the central nervous system, a thorough examination to determine a syphilitic infection should precede any elective operation. This of course would include even such ordinary symptoms as headache and dizziness.

Spinal anaesthesia is usually considered contraindicated in syphilis. Having employed it on scores of frank syphilitics without any unfavorable after-effect, I felt inclined to disregard syphilis as a contraindication. I have, however, observed two cases of cerebro-spinal meningitis after spinal anaesthesia. In both instances, post-mortem revealed the presence of tuberculosis. As syphilis and tuberculosis are so often associated, the question remains open whether spinal anaesthesia in syphilitics can stir up an old tuberculosis. Linzenmeier,¹⁸ who observed meningitis in a syphilitic woman after spinal anaesthesia, brought about a complete cure with salvarsan.

The question of post-operative disturbances in syphilitics becomes complicated because of the fact that all of us have time and again seen perfectly smooth recoveries in individuals whose syphilis was known to us at the time of operation. Comparative statistics of syphilitics and nonsyphilitics, even if extant, would have little value on account of too many variable factors. Menninger²⁰ supplies post-operative statistics of twenty-two cases with four-plus Wassermann. Of these, sixteen, or 72 per cent., had more or less difficulty of wound healing, and six, or 28 per cent., had primary union. If, however, one divides the cases into those where no specific treatment was given, and those where either pre-operative or post-operative therapy or both was administered, the differences between the various groups are insignificant. This may be due to the small size of the series. Goeckerman¹³ concludes from a study of the post-operative records of seventy-eight patients known to have syphilis (1) that patients with syphilis, who have been treated, can be operated upon with impunity; (2) that the patient whose infection is of long duration is on the whole a poor surgical risk, but only in proportion to the damage his tissues have sustained. He is no worse a risk than another patient with an equal amount of damage from some other cause; (3) that untreated patients but rarely (7 per cent.) develop post-operative difficulties.

With such conflicting evaluations of the influence of syphilis upon our surgical results, it is perhaps too soon to arrive at definite conclusions. In the meantime, as I have pointed out elsewhere,¹² every surgeon can help in this important question by thoroughly analyzing his operative cases in regard to positive or negative Wassermans, the possible influence of syphilis upon the causes of death or post-operative complications, the effect of specific treatment before or after operation, etc. It would not be necessary to supply imposingly large figures. A series of thirty or more appendectomies, hernia

operations, hysterectomies, etc., on Wassermann-positive patients contrasted with an equally large series of the same kind of operation on Wassermann-negative persons would yield valuable information; and the publication of individual results would contribute to a great constructive work which would go far to clear the problem and thereby do away with much suffering and failure.

Addendum.—Brief mention at least should be made of syphilitic infection acquired in the course of surgical procedures. Scheuer³⁰ has tabulated the method of transmission in 14,590 extragenital chancres occurring from January, 1896, to January, 1909, and including all cases in which the method of transmission was known. Of particular interest to us—and not a little humiliating—is the number of patients infected by physicians which is no less than 21.92 per cent. of the total number of infections considered. There were 272 cases of infection due to vaccination and forty-six caused by infected instruments, and this points out a moral as to the necessity for scrupulous care in the disinfection of instruments.

Physicians and attendants are constantly exposed to great danger of infection from patients. Scheuer's statistics refer to 168 cases in physicians. In surgeons who are infected during an operation on a syphilitic by needles or other sharp instruments, the inoculation usually occurs direct into the circulation; in such cases there is often no initial lesion, and the disease manifests itself first by secondary lesions. For this syphilis without chancre the French term "*syphilis d'emblée*" is generally used. Almkvist¹ has written on the subject; and more recently Gaucher¹¹ recites the case of a surgeon who cut himself during an operation; he had no chancre on the hand where it was wounded, but developed a typical roseola six weeks later. Such examples can readily be multiplied from literature, and it is probable that many more are never published.

Gaucher also mentions the occurrence of a roseola without a previous chancre, following an intramuscular injection with a needle previously used on a syphilitic.

Another instance of surgical infection given by the same author is that of a woman who during her operation was infected in the peritoneum by an assistant who had mucous patches in his mouth.

Finally, three cases of chancre of the tonsils reported by Wigglesworth,³⁶ Sigwart,³² and Baer² must be mentioned. All three cases concerned physicians who infected themselves by using tracheal catheters on syphilitic newborn.

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SURGICAL TECHNIC *

BY WALTER G. ELMER, M.D.

OF PHILADELPHIA, PA.

PERFECT surgical asepsis in an operating room depends upon the nurse in charge of it. The surgeon is preoccupied with the patient and the successful outcome of the operation he is performing and it is impossible for him to give close attention to everything that goes on around him. He believes in his surgical nurse and trusts her implicitly. Otherwise she would not be there. The nurse has been taught in a more or less formal way by doctors. She has attended the lecture courses given in the hospital where she was a student nurse. But most of her practical instruction has been received from nurses older and more experienced than herself. Her mind has been trained in minute details—details which are often in themselves quite unimportant—and it may not grasp the really important things—matters so vital that they may mean the life or death of the patient. The surgeon may never have given any thought to some of these important things and they may pass unnoticed before him, or he assumes that his surgical nurse has been carefully trained and is carefully carrying out every known principle of surgical asepsis. I have discussed these questions with many operating room nurses and have never found one that was not trying to do her best in conducting her operating room in a faultless manner.

After one has spent several hours in a hospital operating room watching a series of operations, observing every detail of the work of the surgical nurse and her assistants, not only during the operation but also in the interval when she is preparing for the next one, noting the possible links in the chain by which infection could be carried from a septic case to a clean one, and then later spent a half hour or more discussing with the nurse the details of her preparation of the operating room supplies and of all the articles that may be used during the operation—he has a fairly accurate idea of the surgical asepsis which is carried out in that particular hospital, and one should be able to walk away from the hospital with the feeling that he would be perfectly willing to have some member of his immediate family operated upon in that particular operating room under the supervision of that particular nurse.

Let us consider some of the incidents which might occur in a well-conducted operating room which could readily cause a septic wound in an otherwise clean operation. The operator and his surgical nurse might be in a quandary as to the source of the infection. There is no special objection to a surgeon operating in his street clothing except insofar as it affects

* Read before the Philadelphia Academy of Surgery, December 3, 1928.

SURGICAL TECHNIC

his own personal comfort, especially in the hot summer months, but our feeling is that a white duck suit and white canvas shoes are much more in keeping with the surroundings.

The following hypothetical situations suggest the ways by which infection could be carried from a septic case to a clean one:

The surgeon is performing an operation in the region of the hip—a perfectly clean surgical procedure. As he proceeds he finds the position of the patient is not satisfactory and asks to have a sand pillow placed under that side of the pelvis. A nurse goes to a nearby supply room and brings in a sand pillow and while the patient is tilted over to the opposite side she raises the sterile sheet, places the sand pillow under the side of the pelvis and allows the sheet to fall back into place. In a few moments the sheet is saturated with blood which trickles down from the wound or it gets wet from the water dripping from the surgeon's gloves after he has rinsed them in the sterile water basin. The entire field of operation must sooner or later be contaminated with whatever infectious material the sand pillow may carry. Only a few hours before or a day or two before it may have been used in an operation for osteomyelitis, the pus soaking through the sterile sheet or towels has been spread over its mackintosh cover and later dried there. In the absence of direct sunlight these organisms may remain alive for days. We assume that a nurse has wiped off the blood and pus stains but she has not sterilized the sand pillow. Or again, the surgeon is operating upon a septic abdomen or an empyæma of the thorax and the septic material runs down the patient's side and over the iron framework of the operating table. A nurse later washes the glass plates and the white enamel or nickel-plated frame of the table which has been soiled but it is hardly possible that she can sterilize it. This is followed by a clean operation and if the sterile sheet which hangs over the side of the operating table gets wet, the surgeon's gown coming in contact with it can become infected and this in turn infect his gloves.

Infection does not pass through dry sheets or towels but when these are wet the virus of septic material can penetrate quickly through the cloth and contaminate everything within the operation field.

The surgeon is about to operate upon a patient's arm and tells the nurse that he wants the arm outstretched at right angles to the body and then turns to explain to his audience what the operation is to be. Meanwhile a nurse procures a board and pushes it beneath the mattress on the operating table to provide a horizontal shelf. This is covered with a single thickness of sterile sheet, the assistant paints the limb with iodine and carefully washes it off with alcohol, the surgeon turns from his audience to find everything in readiness and proceeds with the operation. In a few moments the sheet is wet and the operation might just as well have proceeded upon the bare board.

We will next suppose that the surgeon and his assistant enter the operating room dressed in white duck suits. The nurse takes out of its

cover a sterile rubber apron which she puts on the operator. The assistant takes down a rubber apron from a hook and puts it on. This has not been sterilized and has been worn during many operations. During the progress of the operation the gown of the operator is very apt to get wet. Possibly the surgeon leans against the side of the operating table or in bending over his patient his gown comes in contact with moist towels which surround the wound—or he may find his gloves so slippery with blood that he cannot tie a ligature securely. He turns to the sterile water basin, washes his gloves and rubs them against the front of his gown to dry them—an operator may do this automatically or quite unconsciously—and proceeds to tie the ligature. The wet gown adheres to the rubber apron beneath it when the surfaces come into contact. But suppose the operation has revealed a perforated appendix lying in free pus. The surgeon's rubber apron has now become infected with a very active septic organism. In the case of the assistant, however, the situation is different. His rubber apron is not sterile. It may have been worn at a previous septic operation and if he does the same thing that his chief does he is carrying infection on his gloves directly into the wound. The operation finished, the surgeon and his assistant remove their gloves and gowns but not their rubber aprons. They go through the usual procedure of scrubbing and cleansing their hands and forearms, put on clean gowns and gloves and turn to the next patient. This one happens to be a clean hernia operation. If the first operation were a clean appendix case there is nothing about the surgeon's attire which can infect the hernia operation. But if the first operation had revealed a ruptured appendix and free pus, the rubber apron is a dangerous menace to his hernia patient as soon as his sterile gown gets wet. The rubber apron of the assistant is a menace to both patients if his gown gets wet. And there may be a sufficient number of operations on the schedule to fill up an entire forenoon or afternoon.

Meanwhile let us see what the surgical nurse is doing. She is wearing a gown with loose flowing sleeves which hang fully six inches below her forearm above the gauntlet of her glove. After each operation she removes her gloves, washes and disinfects her hands and puts on fresh gloves for the next operation, but she wears the same gown throughout the entire series of operations. The instrument tray which is placed just above the patient or within easy reach of the surgeon is covered with instruments which are being used in the operation. The nurse removes them, washes them, replaces them. Her loose sleeves are trailing back and forth over these instruments and likewise over the instruments, ligatures and sutures on her instrument table. If we should question the nurse about this afterwards she would probably tell us that no pus was encountered at any of the operations and as they were all clean surgical cases there was no need for her to change her gown. But how could the nurse possibly know this? We may have noticed that the surgeon carefully tied up the neck of each of the two or three gall-bladders which we saw removed and placed in a sterile vessel for

SURGICAL TECHNIC

a laboratory examination and report on the nature of its contents. If the nurse were right in her contention, why should she change her gloves or why should the doctors change their gloves? But this same nurse is wearing a mouth-guard because she realizes that her speaking voice projects minute droplets of saliva which may carry infection to the ligature or suture which she is holding scarcely a foot away from her mouth.

Ten years ago † we attempted to point out and to emphasize the danger of infection coming through sterile sheets or towels the moment they are wet and we also attempted to point out the best way to guard against this danger. This can be done effectually and absolutely by placing sterile rubber sheeting immediately beneath the sterile sheet or towel. This rubber sheeting is cut into sizes corresponding to an ordinary towel and it is only those areas which are likely to get wet during the operation that need to be thus protected. These rubber towels can be sterilized in only one way and this fact cannot be overemphasized. After they have been washed they must be immersed beneath the surface of boiling water and boiled for five minutes. They *cannot* be sterilized in the autoclave. Live steam cannot pass through rubber. A rubber towel which has been folded several times upon itself and wrapped in a cloth cover must contain air pockets, and this also applies to rubber gloves. When these are packed into the autoclave the live steam reaches the outer surface but cannot pass through the rubber to reach the inner surface. The surfaces with which the live steam comes into contact are sterilized by moist heat but the inner surfaces, where there are air pockets, receive only dry heat sterilization. Moist heat destroys all germs and spores at boiling temperature, 212° F., in five minutes, but dry sterilization requires 350° F., for one hour to kill all germs and spores. The autoclave is operated at two atmospheres pressure or thirty pounds to the square inch for twenty minutes. That is 267° F. moist heat which is more than sufficient to kill every living organism and spore with which the steam comes in contact, but the air pockets are receiving only dry heat sterilization and both the degree of heat and time of exposure are insufficient—almost 100° below the required 350° and forty minutes short in time.

After the rubber towels and gloves have been boiled five minutes they are harmless. They can then be dried and powdered and put away in packages and later when needed can be put through the autoclave as the final step.

Suppose a surgeon uses a rubber sheet large enough to cover the patient completely and hang down over the sides and the foot of the operating table with an opening in the centre similar to the usual laparotomy sheet. If this sheet is sterile it, of course, affords ample protection. But when it becomes soiled with the pus of a septic operation, there is no way by which it can be certainly and absolutely sterilized. The autoclave cannot do it

† ANNALS OF SURGERY, vol. lxviii, p. 646, December, 1918.

and it is too large and bulky to be conveniently boiled unless it be rolled up loosely and boiled in the utensil sterilizer.

If a nurse covers her instrument table with a sterile rubber cover and over this places a sterile cloth, her instruments, ligatures, sutures, etc., are perfectly protected. However, during the progress of the operation she is frequently washing the used instruments and putting them back on the table. The cloth gets wet. At the end of the operation the cloth is removed but the rubber cover remains and perhaps we can see several small pools of water lying in its depressions. A fresh sterile cloth is spread over the table and at once we see the moisture soaking through. The instruments are then arranged on the table for the next operation. Perhaps the preceding operation was an aseptic one, but it might not have been. A fresh sterile rubber cover should be used for each operation. An easier method is to keep the instruments, sutures, ligatures, gauze sponges, etc., on white enamel trays which are sterilized in the utensil sterilizer. Two of these trays, each measuring twelve by eighteen inches, placed side by side on the instrument table are sufficient for any operation.

It is an advantage to use colored towels and sheets rather than pure white. The white coverings reflect the glare of the lights and cause the pupils to contract and this makes it more difficult for the operator to see into the depths of the cavities which must be explored. The white glare from the operating table also makes it more difficult for the visitors to see distinctly the structures revealed at the operation. I have been using dark blue, but dark green is even better for this purpose. If the operator clamps large white gauze pads to the margins of the skin incision, the advantages of using the green cloth are of course lost.

Now, finally, let us consider a single hypothetical case and attempt to analyze it. A patient in apparently good health has been advised to have a serious operation performed. He selects a surgeon in another city and enters a hospital in that city. The operation is performed as skilfully as it could be performed anywhere. The patient was in the lithotomy position and the incision was through the perineum. His temperature was normal the next morning and his condition in every way satisfactory. It was what we usually consider a clean surgical case. But by evening the patient's temperature had risen considerably and in two days reached 106° F. There was nothing about him to account for his high temperature and rapid pulse except deep infection in the wound. We could not accuse the colon bacillus in its normal state from a healthy bowel of causing a temperature of 106° . A virulent organism was at work in the deep tissues—probably the staphylococcus aureus or hæmolytic streptococcus or both. Every means that could be used to save the life of the patient was used and after a long illness he recovered. We naturally ask ourselves what could have been the cause of such a desperate illness when a normal convalescence was expected. We can, I think, dismiss the gloves, instruments, ligatures and

SURGICAL TECHNIC

sutures from consideration. We have left then but two possible carriers of dangerous infection. If a Kelly pad were used, and it probably was, it may have been soiled with the septic discharge of some previous patient and although it had afterwards been washed it was still carrying the infection. The sterile sheet which had been tucked under the patient to hang down and cover the pad was soon wet with blood and wherever it adhered to the rubber pad infection could come through. Instruments such as tenaculum forceps and hæmostats hanging from the wound could become infected as well as the gloves of the operator and his assistant. The other object which we might suspect is the rubber apron which the operator is wearing beneath his gown. He is sitting on a stool as he performs the operation and his gown will almost certainly get wet. It would be most difficult for him to avoid it. If the rubber apron were not sterile, infection quickly comes through. The rest follows as a natural sequence.

We recall two cases that were published in the public press. Both were young women who insisted upon having their lower limbs straightened as they felt self-conscious on account of moderate bow-legs and short skirts. An osteotomy was done in each case. The result was most unfortunate in both instances. The first patient on the Pacific Coast had to have one leg amputated and the second patient, in the Middle West, had to have both legs amputated. We can only surmise what complications made this necessary. In the first case it might have been due to damage to the blood vessels lying on the outer surface of the tibia—the osteotome having been driven completely through the bone instead of about three-quarters of the way through and a greenstick fracture made in the outer portion. In the second case it may have been caused by infection carried into the marrow cavity by the osteotome. This seems to be the more likely explanation as this patient had a temperature of 105° before her legs were amputated. The explanation of the infection might be found in some of the suggestions which have been made in this paper.

A few days ago a special despatch to the *New York World* stated that a young woman in Paris, about to be married and eager to appear in a wedding dress with a short skirt decided that her calves were too fat to look well. She insisted on an operation to make them slender. One calf was operated upon but the foot turned black and it became necessary to amputate her leg. It hardly seems likely that the blood supply and nerve supply of the leg and foot could be so damaged by an experienced surgeon that gangrene would result. It is much more likely to have been due to infection.

Surgeons will sometimes hesitate to recommend an operation because of the danger of infection. Every surgeon takes every possible precaution to safeguard his patient against this danger. It is the unsuspected source of infection that is the most difficult to guard against.

TRAUMATIC FACIAL PARALYSIS AND ITS SURGICAL TREATMENT BY FREE TRANSPLANTATION OF FASCIA LATA *

BY HERMANN FISCHER, M.D.

OF NEW YORK, N.Y.

THE operative treatment of complete facial paralysis was introduced by Ballance in 1895. In applying his operation to the facial nerve he followed the method of Letiévant which this author had described as "*greffe nerveuse*" for injuries of the motor nerves of the extremities. Ballance himself was not successful in his case, but three years later Faure and Furet, who performed the operation independently of Ballance, were rewarded by a good result.

It was natural that in injuries to the peripheral nerves direct suture of the divided stumps suggested itself and when this simpler method could not be applied for some reason or other, the more complicated operation of transplanting functioning nerve fibres into the paralyzed nerve was devised. In the event of a facial paralysis direct reunion of the divided nerve is only possible along its very short course, after it emerges from the foramen in the bone to the point of division into its various branches, a distance hardly more than two inches. If the lesion of the nerve happened to be along its course in the bony canal an end-to-end suture was impossible.

The most frequent cause of facial paralysis, except in injuries by weapons and bullets, are surgical operations on the parotid, on the structures of the neck, and operations for purulent otitis media and mastoiditis. In order to reestablish the function of the nerve it was necessary to effect an anastomosis between the peripheral stump of the facial and the central stump of some motor nerve lying in its neighborhood. Ballance, Faure and Furet have used the accessory nerve or one of its branches—the *ramus sternocleido-mastoideus* or the *ramus trapezoideus*. Koerte, in 1903, employed the hypoglossal nerve and this hypoglossal-facial anastomosis was acknowledged by most surgeons as the best method, and has been often used since then.

The results of this anastomosis have been very good in a large number of cases. The tonus of the muscles of the face was reestablished usually after several months, the drooping angle of the mouth was straightened, the disagreeable drooling of saliva ceased and when the patient's face was at rest, his facial expression was almost normal. The lagophthalmus was influenced to a lesser degree.

The disadvantages of the operation were annoying simultaneous movements of the face when the muscle groups were moved which were supplied originally by the nerve used for the anastomosis. When the accessory nerve had been employed muscular contractions occurred in the muscles of the face

* Read before the New York Surgical Society, November 14, 1928.

FASCIA LATA TRANSPLANTS FOR FACIAL PARALYSIS

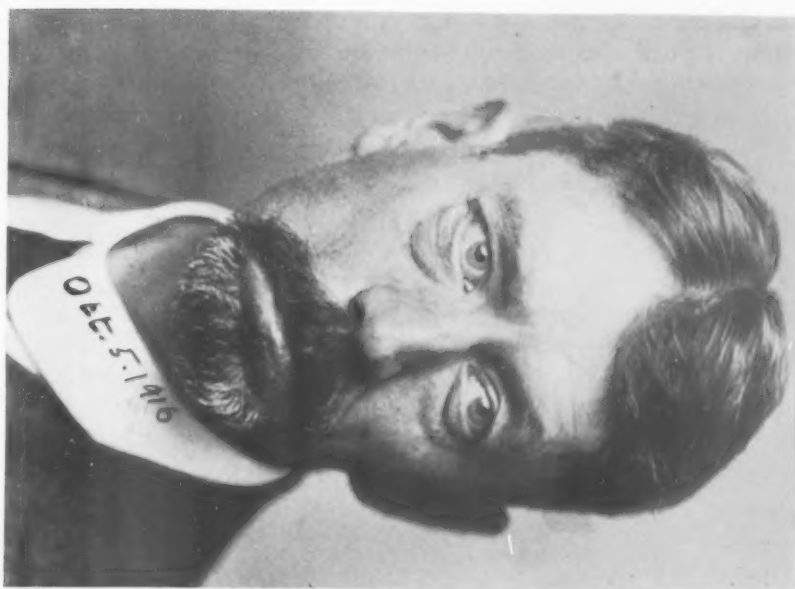


FIG. 1.—Hypoglossal-facial paralysis, before operation.



FIG. 2.—Final result obtained by facial transplantation.

whenever the upper arm or the shoulder was raised; if the hypoglossus had been used movements of the tongue caused corresponding movements in the face. At the same time, it was very difficult for the patient to move his facial muscles without also moving his arm and shoulder or his tongue. Only in very exceptional cases has the patient been able to move his facial muscles independently. A further disadvantage of nerve anastomosis is the loss of function in those muscle groups supplied by the nerve employed for the anastomosis. In cases in which the accessory nerve had been used the patient was unable to move the shoulder or arm with its full force.

After hypoglossal-facial anastomosis naturally an unilateral paralysis of the musculature of the tongue followed, which led to very disagreeable functional disturbances, especially in the first few months after the operation. The paralysis of the tongue makes speech, swallowing and eating difficult. It is true, however, that these disagreeable symptoms disappear after two to three months and the patient learns to use his tongue in the normal fashion.

The accompanying photographs (Figs. 1 and 2) show a patient before and after operation on whom, eleven years ago, I performed a hypoglossal-facial anastomosis. Two years before I saw him, this patient had suffered from a very severe and extensive septic phlegmon of the neck with secondary necrosis of the mastoid process and temporal bone, in the course of which the facial nerve along its course through the bone had been totally destroyed. The patient was, on account of the continual drooling of saliva and trickling of tears, totally incapacitated for work, and consequently was very much depressed and despondent. The operation was a very difficult one on account of the dense scar tissue. The result of the operation was cosmetically excellent, as the photographs show, but isolated innervation of the mimic muscles of the face he never attained. In a second case I had a similar good result, although in this case the paralysis had lasted over seven years. Both patients, however, complained bitterly for several months about the paralysis of their tongues.

In judging the value of the nerve anastomosis for facial paralysis, F. Kraus says: that a complete restitution of the extraordinary fine mimic movements which the normal innervation of the facial nerve produces, must never be expected. What we wish and what we accomplish with these different methods is, therefore, not the reestablishment of the extremely differentiated facial nerve tracks, but the improvement of the disturbances which have been caused by the paralysis which not only disfigure the patient, but handicap him socially.

In those cases in which a result was not obtained, in spite of the nerve anastomosis, one has tried to improve the deformity by a muscular plastic. For this purpose a number of methods have been recommended. Gomoiu and Jianu have used a pedicle flap from the sternocleido-mastoid muscle. This was led through a subcutaneous tunnel to the commissure of the lips and anchored there by percutaneous sutures. O. Hildebrandt demonstrated before the German Surgical Congress in 1913 a case in which he had done a similar muscle plastic with great improvement. The disadvantages of this

FASCIA LATA TRANSPLANTS FOR FACIAL PARALYSIS

operation are, that, with every movement of the head the angle of the mouth is pulled down. Jianu therefore, suggested instead of the sternocleido-mastoid to use a flap from the masseter muscle. Lexer has made the same proposition. The muscle flap, with its pedicle toward the zygoma, is turned toward the angle of the mouth, its free end is divided into two parts, one of which is sutured to the upper lip, the other one to the lower lip. The results were cosmetically not very brilliant.

Besides nerve anastomosis and muscle plastic operations in facial paralysis, one has tried to improve the deformity by a simple mechanical suspension of the angle of the mouth. According to Momburg, Busch has employed a loop of an aluminum-bronze wire which he fastened to the periosteum of the zygoma and which he looped subcutaneously around the angle of the mouth, the wire being pulled taut until the angle of the mouth on the paralyzed side of the face was on the same level with the normal side. Momburg has performed this operation in five



FIG. 3.—Facial paralysis before operation.

cases with slight modification of suspending the loop of wire from the zygoma itself. The cosmetic result was good.



FIG. 4.—Facial paralysis. Patient shown in Fig. 3 after fascial strip operation.

In March of this year (1928) I was consulted by a young girl of eighteen who had since early infancy a complete paralysis of the left side of the face. When ten weeks old a tumor the size of a walnut was noticed at the angle of the inferior maxillary bone just below and behind the lobule of the ear. A surgeon extirpated the tumor and immediately after the operation it was noticed that a complete facial paralysis had developed. In the course of the years her paralysis improved to a certain extent, the muscle tone returned somewhat, and the lagophthalmus improved, but there was still present a considerable flattening of the whole left side of the face. The left angle of the mouth droops considerably, the left naso-labial fold is very shallow and hardly visible, and there is still a slight lagophthalmus present,

as she cannot entirely close the left eye. Since she has grown up, the young girl is very conscious of her deformity, she is psychically depressed and does not like to mix with people as she continually thinks about her crooked mouth.

The neurological examination, which was kindly done for me by Dr. Foster Kennedy, showed that a part of the facial nerve was functioning and I, therefore, decided not to

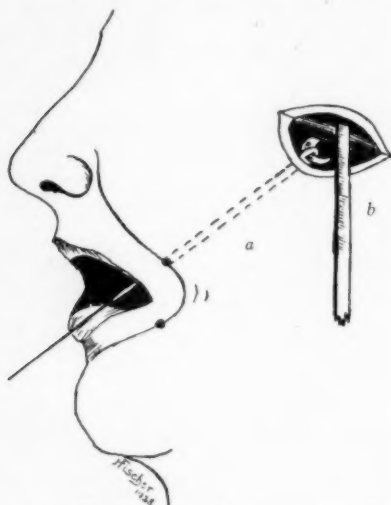


FIG. 5.—*a* Needle lying subcutaneously. *b* Fascial strip looped around zygoma.



FIG. 6.—Incision in buccal mucous membrane.

do a nerve anastomosis but to use a procedure first which would not endanger the little nerve function which she had regained; secondly, one which would not leave a visible scar and still would have the desired cosmetic effect.

I, therefore, did a free transplantation of fascia lata to improve the deformity. The

operation was done on March 6, 1928, under general anesthesia. A fascial strip, twenty centimetres in length and about two centimetres wide, was excised from the fascia lata. A small incision was then made through the skin over the zygoma and with a properly curved aneurysm needle the strip of fascia was looped around it. One end of the strip was then armed with a long straight needle which was pushed along subcutaneously towards the angle of the mouth until it reached a point on the upper lip, about one centimetre above the commissure of the lips. The cheek was then everted by an assistant and, after careful cleansing of its mucous membrane and painting it with iodine solution, the needle was pushed through the mucous membrane and the fascial strip pulled through. From the point of emergence of the fascial strip a small incision was made vertically downward through the mucous membrane to a point one centimetre below



FIG. 7.—Position of fascial strip.

the commissure. At this point the needle was pushed through the musculature of the cheek under the skin and its point made to reappear in the small incision over the

FASCIA LATA TRANSPLANTS FOR FACIAL PARALYSIS

zygoma. The loop of the fascial strip now took in the insertions of the *musculus zygomaticus* and the *musculus risorius* at their points of insertion at the angle of the mouth. The loop was now pulled taut until the angle of the mouth on the paralyzed side was on a level with the normal side. The two ends of fascia were then knotted together and fastened with a few chromic gut sutures to the masseteric fascia. (Figs. 5, 6, 7.) Immediately after the fascia strip had been placed a normally deep naso-labial fold appeared, but at the same time there was noticed a slight dimpling of the skin below the lower lip. This slight deformity was rectified by pushing a Cooper's scissors through the small incision in the mucous membrane of the cheek and by subcutaneously mobilizing the skin from its attachments to the deeper tissues where the dimpling was present. The small wound in the mucous membrane of the cheek was closed by a running suture of catgut and the skin incision over the zygoma was closed by a few interrupted sutures of silkworm gut. On the fourth day post-operative the skin sutures were removed. Two days later a little swelling of the wound with a slight amount of oozing of serous secretion was observed. The knot of the fascia strip had become necrotic and was lying free in the wound; this was removed and after a few days the wound had closed. At the angle of the mouth, at the point where the skin had been mobilized, a small hematoma had appeared. This, however, was absorbed after two weeks.

The result of this little operation was very gratifying. The mouth was now straight, the naso-labial fold had a normal appearance and the flattening of the cheek had disappeared. It is my conviction that this simple operation should have preference in cases of facial paralysis before the other more complicated plastic operations.

The results of the nerve-anastomosis are cosmetically not any better and have the disadvantage that it takes almost a year before an improvement can be expected and that they produce secondary disturbances which take several months to overcome. Muscular flap plastics cause visible scars in the face and are also cosmetically not very successful. At any rate this fascial strip plastic recommends itself by its simplicity and by the absence of a subsequent scar. The operation can also be done immediately after the occurrence of the paralysis if it is of traumatic origin, without in any way interfering with the recuperative powers of the injured facial nerve and at the same time the patient is saved a good deal of worry about his disfigurement.

NOTE.—After this paper went to press I ran across an article of Dr. E. Koenig, Koenigsberg in Germany, in which an identical method of fascia plastic in facial paralysis is described which was published by Kirschner in 1913 in Brun's *Beitraege zur klin. Chirurgie*. This publication of Kirschner has escaped my attention. The priority of the operation therefore belongs undoubtedly to Kirschner.

WHEN AND WHEN NOT TO OPEN THE ABDOMEN IN ACUTE SURGICAL CONDITIONS*

BY JOHN B. DEAVER, M.D.

OF PHILADELPHIA, PENNA.

THE most significant development of modern surgery is its comparative safety. In other words, when we undertake an operation, we do so with a degree of confidence as to the immediate result little dreamed of by our forefathers, who practically always faced the dire apparitions of suppuration and gangrene that stalked in the operating rooms of old. This comparative certainty as to immediate results, however, is not the end-all and be-all of surgery. Our main concern, next to the safety of the operation, is the removal of pathology with a minimum of traumatism so as to make for the restoration of function and the final cure of the patient.

While the prerequisite for successful therapy of any kind is a proper diagnosis, surgical treatment demands a knowledge of the physiological processes involved in a given case and their relationship with the possible immediate and remote reaction to the contemplated operative procedure. For it is a self-evident fact that disturbed function of one important organ necessarily has its more or less deleterious effects on other organs of the body. This fact emphasizes the importance, not only of surgical diagnosis and surgical physiology, but of surgical judgment, which, when applied to abdominal surgery, means knowing when and when not to open the abdomen.

Of primary decisive importance is the constitution of the individual concerned. The modern laboratory, I am glad to say, has provided us with a series of tests that have done much to add to the safety of surgery to which I have already referred. Urinalysis, kidney functional tests, liver functional tests, blood chemistry, etc., are the inevitable preliminaries of every operation except the urgent emergencies. Even in the emergency cases it is the practice in the Lankenau Clinic to have a blood urea, blood sugar, blood count and urinary examination of a catheterized specimen made at or immediately before the patient is prepared for operation. In cases where the blood sugar is high, we at once give a dose of insulin. I am insistent upon this and upon the maintenance of the bodily heat, which is best obtained by the method of Crile—diathermy. With these tests has come the necessary advance in pre-operative treatment by which an otherwise poor risk can be brought within the margins of a safe operative risk. Another contributing factor to this end is the development of local anæsthesia, including intraspinal, by which certain conditions that were at one time inoperable have now been transferred to the operable category.

* Read before the Medical Society of the County of Kings, Brooklyn, New York. November 2, 1928.

WHEN AND WHEN NOT TO OPEN THE ABDOMEN

Turning to the subject at hand, you will all agree that the first step is to decide whether or not a given case of abdominal disease is surgical. Without stopping to enumerate the conditions that are definitely not surgical, I should like to mention at least one about which a doubt exists; that is, visceroptosis, or splachnoptosis, to employ the more comprehensive term. In spite of the fact that the various "pexies" that have been devised to remedy this condition have generally been relegated to the discards of surgery, I still see some patients on whom the operation has recently been done, without relief, of course, and who clamor for further surgery. These are decidedly cases in which the abdomen should not be opened. I might also include nephropexy in the list except that it occasionally does good where other means fail.

Before a positive opinion is given on the visceroptotic patient an X-ray study is usually asked for. I do not object to this except from the economic standpoint. With very few exceptions we make the diagnosis without a röntgenological study. We are satisfied with the clinical study which includes the appearance and general make-up of the patient, together with nervousness, constipation, indigestion, gaseous distention, pain or discomfort referred to the upper abdomen, frequently suspected to be a gall-bladder condition or duodenal or gastric ulcer or chronic appendix, and occasionally subjected to operation on such a suspicion. Careful physical examination will detect the low stomach, a low colon and a mobile cæcum, both of which splash on palpation, and a movable right kidney. When the transverse colon is in the pelvis, by elevating the latter to the highest point possible, the colon, as well as the sigmoid, if redundant, will ascend to the upper abdomen, where they can be made out by percussion. Or by having the patient take a dose of castor oil the night before and an enema the morning of the examination, if one prefers, by injecting the colon with air the condition is readily made out. Often the X-ray report reads: "Colon fixed in pelvis." But in the many operations we do for other conditions in the visceroptotic patient I never find the transverse colon adherent in the pelvis; on the contrary, I can always lift it out of the abdomen and casually remark: "This transverse mesocolon is so long and lax that I could easily carry it down to the patient's shoe-tops." Mild colitis is frequently present. This is enough to clinch the diagnosis, as well as to demand suitable treatment.

The treatment consists of having the patient sleep with the foot of the bed well elevated, taking properly-directed exercises and gymnastics, general massage, including the abdomen, the manipulations to be made from below upward, live in the open as much as possible, forced feeding of nutritious foods, and the adjustment of an abdominal support, by which, when in position, the fluoroscope will show the prolapsed viscera to be held up to where they normally belong.

Our more immediate concern, however, is to decide the question of timely intervention in the acute disorders of the abdomen that are definitely surgical. The decision represents one of the niceties of surgical judgment. It is a well-known fact that surgical risk today means much more than con-

sideration of the patient's heart, kidneys and lungs. These elements, as I have already indicated, are more or less controllable, so that they may be said to be extraneous. It is the intraneous conditions that demand the serious attention and tax our diagnostic acumen. Acute abdominal conditions resemble each other more or less, so that, oftentimes, opening the abdomen is the only means of determining the seat of the disorder. The important thing is to recognize that operation is demanded and to act upon that knowledge, not to watch and wait, but to look and act.

Without doubt the most common ailment in the aforementioned class is *acute appendicitis*. In spite of the voluminous literature and publicity pertaining to this subject, its mortality still remains entirely too high. In trying to place responsibility for this unsatisfactory record, it may be said to be divided between faulty diagnosis and either precipitate or procrastinating surgery. It is true, the fault does not always lie with the doctor. Oftentimes he is not called until the condition has passed the early and most favorable stage for operation. This applies particularly to children where the difference between an ordinary bellyache and acute appendicitis is not always easy to recognize. I believe, however, that the severe bellyache in the child is, in the majority of cases, appendical in origin, and, further, that recurrent attacks of acidosis can be prevented by the removal of the chronic appendix so commonly diseased, not only in children, but in adults as well. Furthermore, I need only mention that, in children particularly, the onset of pneumonia very often simulates an acute appendicitis. To open the abdomen in such cases would, of course, be serious. This alone emphasizes the importance of a careful history and painstaking care in making the physical examination. But outside of such an emergency, the element of error in diagnosis still plays too great a rôle in our mortality records. Abdominal pain, tenderness and more or less rigidity of the muscles of the lower right abdomen, nausea, vomiting, constipation or, sometimes, diarrhoea, should be enough to arouse suspicion of the nature of the disorder. The modern trend is to depend on the leukocytic count to clinch the diagnosis. As I have repeatedly said and say again, for me the degree of abdominal tenderness is much more decisive than the degree of leukocytosis. This, of course, demands experience and the light touch which is so valuable an asset to every surgeon. The degree of tenderness is the storm signal of the diseased appendix by which it clamors for relief from the impending disaster of peritonitis. To wait for a high leukocytosis often means the breaking point of the storm with relief delayed until the storm settles down. Very often, also, judgment is lulled, if not dulled, by the subsidence of the acute pain. Needless to say, that too often this means gangrene. The time to open the acute abdomen where the appendix is suspected is before peritonitis has developed. If that moment has been missed, then waiting for localization of the peritonitis, if diffused, is often the best bet. I have no patience with the doctor who boasts that he opens the abdomen no matter what the stage of peritonitis may be; in passing I may say, nor do I envy him his death rate. Localization of the peritonitis can,

WHEN AND WHEN NOT TO OPEN THE ABDOMEN

with few exceptions, be brought about by regulation treatment, anatomic and physiologic rest, which is familiar to all of you.

In the average case of acute appendicitis, if seen early, there should be no doubt about the diagnosis. It is after a diffusing or diffused peritonitis is present that doubt may be injected, so that we must place our reliance mostly upon the history, since in the presence of advanced peritonitis, physical examination becomes less certain. It is in the latter type of case that immediate operation too often adds to the death toll, and is one reason why the mortality records in this disease are much too high. I want to stress this point as I know the position I take is sound, being based upon many operations performed at the most opportune time. I never make an enterostomy or high jejunostomy in these patients. We, in the Lankenau Clinic, get these patients well, with few exceptions, without one or the other of these operations.

The difficult diagnosis in early appendicitis is where the appendix holds a high position lateral to or behind the cæcum and colon, or medial to the cæcum, or deep in the pelvis when tenderness and rigidity, on account of the distance the appendix lies from the abdominal walls, make external examination less certain, but where rectal and vaginal examination will often materially aid in forming a correct opinion. In this connection I want to emphasize the presence of left-sided lower abdominal pain in pelvic appendicitis, often associated with irritation of or inability to empty the bladder, and requiring catheterization. I see many such cases where the diagnosis is overlooked with consequent irreparable damage. In advanced pelvic abscess in the male, it is best to open by incision carried through the anterior rectal wall, unless it can be done safely through a mid-line incision immediately above the pubic bone, a catheter having been previously passed; in the female, by incision through the vault of the vagina posterior to the cervix.

While deaths caused by acute appendicitis are primarily the result of the appendical disease itself, secondarily they are the result of peritonitis and the toxæmia which it causes. Experience, bacteriological study, autopsy *in vivo*, and post-mortem examination have taught us that peritonitis plays the most important rôle in the mortality.

The pivot around which the logical treatment of acute appendicitis revolves is not so much the appendix as it is the peritonitis. In an illustrative way, the peritonitis has been likened to a conflagration caused by a lighted match. If the match is still burning when the firemen arrive, it does not attract their attention so much as does the conflagration; therefore, their efforts are at once directed to prevent extension to the surrounding buildings. So, in the presence of an appendical conflagration, the appendix can be forgotten and attention centred upon the prevention of further extension of the peritonitis.

In acute appendicitis, in the presence of peritonitis, the pith of the question is when and when not to open the abdomen to obtain the best results and the minimum mortality. I believe that, in the absence of a forbidding

peritonitis, acute appendicitis should be operated on immediately, except in the presence of some grave constitutional condition. In the absence of contraindications, be the case ever so mild, or the patient apparently on the high road to recovery, to advise waiting for an interval or a second attack shows ignorance of the possible effects of delay, and is contributory negligence in case of death. I make this statement fully conscious of its meaning. To advise interval operation only because the patient contemplates a long visit away from home, is also a dastardly practice. In support of these utterances, I am prepared to say that the occasional operator should not be the one chosen to do the work, but the operator of vast and varied experience in dealing with the pathologic abdominal riddles, as he can best deal with any of the many complications that may be present; with this proviso, I am willing to stand back of what I have said.

In the presence of a circumscribed peritonitis, removal of the appendix with the proper technic is correct. By the proper technic, I mean that the incision should be made lateral to the point or line of greatest tenderness which indicates the position of the appendix. We should not hesitate to cut the internal oblique and transversalis muscles in a direction opposite to the course of their fibers, if this gives easier and better exposure. To operate with the view of preventing a subsequent hernia is to expose the patient to the greater and more serious risk of dissemination of infection. If the appendix lies close to the cæcum and is directed upward and outward, an extraperitoneal approach is the safest route and is easily made, when, after the overlying muscles have been cut through, the transversalis fascia, which is often cedematous and infiltrated, can readily be separated from the peritoneum and the latter exposed. At this point, palpation will often detect fluid. Hypodermic aspiration will definitely determine the character of the fluid. The peritoneum is opened in the line of the wound, the fluid, pus or puruloid material evacuated, and the cæcum and appendix exposed.

A circumscribed peritonitis is easily recognized by the presence of a limited swelling, limited rigidity, limited tenderness, circumscribed pain, and either the absence of peristalsis or hypoperistalsis as compared with the peristalsis surrounding the peritonitic area, together with resonance to light percussion, but dulness and flatness to deep percussion, and limited movement of the abdominal walls over the site of the lesion. In making the diagnosis the physical signs are of the greatest importance. A leukocytic and polynuclear count should be made as a routine measure, but in the majority of instances, I attach little importance to either. When I do consider the blood picture, I pay more attention to the polynuclear than to the leukocytic count.

In circumscribed appendical peritonitis with the abscess close to the ileocæcal junction beneath the terminal ileum and mesentery, and with the terminal ileum thickened and stiffened, having to a great degree, if not entirely, lost its contractile power, after the pus is evacuated, the appendix removed and drainage established, an ileocolostomy, or, sometimes, an

WHEN AND WHEN NOT TO OPEN THE ABDOMEN

ileocecostomy, will make recovery more certain, in that it prevents obstruction immediately or later. I have done this many times with most satisfactory results.

Let us now consider diffusing peritonitis, by which is meant a spreading inflammation not involving an extensive area and differing from the circumscribed variety in that it is not limited. In the diffusing peritonitis, there is both peritoneal irritation and peritoneal inflammation, the former being the forerunner of the latter. You may regard this as a distinction without a difference, but I hope to show you that it is not. Diffusing peritonitis differs from circumscribed peritonitis in that although the patient looks sicker, he does not have the peritoneal facies. The pain is more pronounced and is referred over a greater surface; there is a much larger area of rigidity and tenderness, peristaltic sounds are either absent or very feeble, or peristalsis is aggravated around the inflamed area corresponding to the area of peritoneal irritation, and abdominal breathing is more limited than in circumscribed peritonitis. Diffusing peritonitis is definitely recognizable by the careful observation of these physical signs. Time and again I have demonstrated this to my classes and subsequently proved it at operation by the presence of inflammatory adhesions, adherent coils of bowel and adherent omentum occupying the area mapped out as the site of the inflammation when examining the case before the peritonitis had subsided. Cases of diffusing or spreading appendical peritonitis presenting rigidity should be operated upon in that stage, as thus the spread of the peritonitis will be prevented. But unless operated upon at that opportune time operation should be postponed until the subsidence partial or entire of the peritoneal inflammation, which, in the experience of the Lankenau Clinic, practically always takes place if strict anatomic and physiologic rest, "regulation," as we call it, is carried out.

Diffused appendical peritonitis, in its early stage, presents a picture familiar to us all, with its general rigidity of the anterior abdominal walls, tenderness corresponding to the area of rigidity, absence of abdominal breathing, the peritoneal facies, rapid, tense and often bounding pulse, comparatively high temperature, and exaggerated peristalsis. The blood picture shows 18,000 to 20,000 leukocytes, and eighty-five to ninety-five polynuclears, the latter varying with the type of infection. Twenty to forty hours after onset of the peritoneal inflammation, or earlier if the patient has been purged, the picture changes to one of general abdominal distention, the rigidity being much less pronounced, tenderness not nearly so decided, entire absence of peristalsis, later followed by tinkling, and, finally, a silent belly, an ominous sign, when only the pulsation of the abdominal aorta is heard louder than normal, and a rapid pulse, with diminished volume; more pronounced peritoneal facies, a blood picture of moderate or low leukocytosis, but high polynuclear count, diminished output of urine that shows albumin, hyaline and granular casts, relaxed skin that later is sweaty and cyanotic, vomiting or regurgitation of dark vomitus, often foul-smelling, and restlessness, and an active brain. This presents what is usually considered a hopeless propo-

sition, but not necessarily so, if the treatment already described is carried out early and to the letter. I have seen recovery with local abscess formation, the simple evacuation of which was followed by convalescence. When much of the active peritoneal inflammation has subsided, but has left multiple foci of pus, the patient dies of toxæmia. When the peritoneal inflammation has only partially subsided and has left a large collection, involving the pelvis and the lower abdomen, the patient may, sometimes, by instituting drainage alone, get well. These are cases in which puncture through the rectum or the vaginal vault has occasionally proved successful.

A condition that requires keen diagnostic and surgical judgment is *acute intestinal obstruction*. There is, perhaps, no acute disorder in which waiting for the fully-developed clinical picture is more disastrous; in other words, refinement of diagnosis may bring no other satisfaction than to be able to say at the autopsy: "I told you so," which, of course, does the patient no good.

One important aid to diagnosis in this condition, naturally, is the history of a previous operation, for, as you all know, post-operative intestinal obstruction may occur at any time, immediate or remote, after an operation. The condition requires quick judgment and quick action. In the presence of an abdominal scar, the result of a previous abdominal operation, in a patient suddenly stricken with acute intermittent abdominal pain, one should first think of intestinal obstruction. Its usual characteristics are: Sudden onset of intermittent colicky pain, persistent vomiting, normal pulse rate and usually normal, but sometimes slightly subnormal temperature, contraction of the affected bowel, as evidenced by early stormy peristalsis with visible coils, and later, faint tingling or absent peristalsis, and meteorism. Of course, when the vomitus becomes stercoraceous, the diagnosis is evident. The thing is to obviate this latter and usually fatal stage.

Besides the information given by percussion and auscultation of the belly, the contour of the walls should be observed. Asymmetry, together with an area of intestine which, in spite of tympany, is more resistant than elsewhere, should suggest ileus, and a distended bowel and a silent belly mean either severe intestinal paralysis or peritonitis. Added to the picture in the late stage are the subjective symptoms of rapid, weak pulse, shallow breathing, anuria, and the anxious facies. The differentiation between the various forms of obstruction is not of moment. Of most moment, is to get into the abdomen as early as possible and to get out as soon as possible.

In acute obstruction following a previous operation, or in cases of obstruction at the foramen of Winslow, or a tear in the mesentery, the patient will often point to the site of the obstruction as the primary location of the pain. This item should not be lightly dismissed by the doctor as of no importance, for it often proves a valuable guide.

In passing, it may be said that *volvulus*, usually of a redundant sigmoid, is the form of obstruction that differs from ordinary acute obstruction, in that the abdomen becomes greatly distended almost immediately following

WHEN AND WHEN NOT TO OPEN THE ABDOMEN

the sudden onset of intense acute pain. This should suggest the form of obstruction in question and, needless to add, opening the abdomen at once on account of the early appearance of gangrene which too often means fatality. Incidentally, upon opening the abdomen in this type of obstruction before gangrene has occurred, it is my practice, after reducing the volvulus, to anastomose the proximal and distal limbs at their roots. This is a safe procedure if skilfully and carefully done, and provides not only an uninterrupted recovery, but prevents recurrence. I have done this a number of times with gratifying results.

In children *intussusception* should be thought of in connection with the above-named train of symptoms, plus bloody and mucous stools, and, usually, the presence of a tumor on abdominal or rectal examination; the latter should be made in all cases of obstruction. In *intussusception*, the paroxysms of pain occur at frequent intervals. These cases demand immediate operation; any delay may, and usually does, prove fatal. Medical treatment and rectal injections with the hope of relieving the *intussusception* should not be countenanced.

Of the acute diseases of the lower abdomen, the appendix excepted, those of the pelvis are the ones that most frequently arouse the question of when to operate and when not to operate.

In general, it may be said that *acute puerperal infection* had best be treated symptomatically by anatomic and physiologic rest, unless drainage is indicated, although a residual lesion may later require intervention. *Acute salpingitis*, especially in the unmarried female, and, also, when due to gonorrhœal infection, likewise does better under expectant treatment unless, of course, complications occur. Many claims are now being made for the value of the sedimentation test in acute pelvic conditions as of material assistance in determining the opportune time for operation, as well as the prognosis in pelvic infections, to which I strongly subscribe.

The abdomen should be opened at the earliest possible time in cases of *ovarian tumor*, or a *uterine fibroid twisted on its pedicle*; or *bleeding caused by a ruptured cyst of the ovary* (I have known the last-named to occur at the menstrual time where the patient had been dancing the greater part of the evening); *ruptured ectopic pregnancy*, *placenta prævia*, *accidental hæmorrhage in the pregnant woman*, *ruptured uterus*, and *perforation of the uterus*, accidental or otherwise.

In a *chronic pyosalpinx*, the result of a gonococcic peritonitis or a post-*puerperal infection* operation is indicated, while the early cases should positively not be operated. These patients, in my experience, if treated by masterly inactivity, recover, as a rule, without mechanical interference.

In a limited number of *post-*puerperal abscess** cases, evacuation through the extraperitoneal approach, above the lateral half of Poupart's ligament, is best.

There is no class of case in which surgical judgment can be better displayed than in this one. The post-*puerperal infection* that does not subside,

but goes on to pus formation, should be operated by the extraperitoneal approach above the outer half of Poupart's ligament, carrying the incision well lateralward, or by incision into the culdesac through the vagina. In passing, let me say that in our clinic, where we see so many cases of late abortion, we do not practice curettage when there is temperature or any signs of peritonitis, or of peritoneal irritation. Anatomic and physiologic rest, carried out in its entirety, will give the desired result. Without wishing to rap the young general surgeon or the young obstetrical surgeon, I beg to say he should stop, look and listen. Did time permit, I am sure I could carry this discussion far along with benefit to some, at least.

Retroperitoneal lymphangitis of the right lower abdomen, giving rise to tenderness and rigidity, is not unlike the picture of an appendical inflammation, but is attended by higher temperature and pulse-rate, depending upon the particular organism responsible for the condition. For example, the staphylococcus albus carries an hemolytic infection with most pronounced constitutional reaction. Blood smears will show as high as 800 colonies to the microscopic field. A persistent high temperature with corresponding depression of the patient should at once excite suspicion.

In my opinion, these cases are usually fatal, do what you will. I have seen a number, practically all of which have ended fatally. They result, usually, from an abrasion which, if cultured early, shows the staphylococcus albus. The local diagnosis is made by the presence of enlarged inguinal glands of the affected side and of the glands in the pelvis, immediately above Poupart's ligament. This, together with constitutional symptoms that seem out of proportion to the local findings, makes the diagnosis, and indicates that the abdomen should not be opened.

The abdomen should be opened in the early case of *perforated diverticulitis of the sigmoid*. In the late case of sigmoidal diverticulitis, and active peritonitis, it is better not to operate until there is positive localization, and preferably not until abscess formation. When the latter has taken place, the extraperitoneal approach is preferable. Many of these cases have perished from too early operation.

Turning to the upper abdomen, the most frequent cause of acute symptoms is an *inflammation of the gall-bladder*. Such an inflammation, if ultra-acute, whether phlegmonous, perforative, or gangrenous, demands immediate operation as soon as the diagnosis is made. The acute, especially the non-calculous inflammation, on the other hand, which is more common than the ultra-acute, with very few exceptions should not be operated upon until the active stage has passed, since the attack will subside under proper treatment—*anatomic and physiologic rest*. The thing to do is, first, to give morphia to relieve the pain; secondly, wash out the stomach; thirdly, apply ice to the painful area and start proctoclysis, using normal salt solution; fourthly, withhold all water or nourishment by mouth until peristalsis is heard or the patient passes gas. If this treatment is carried out to the letter, the attack will subside, after which the case can be studied and the best time selected

WHEN AND WHEN NOT TO OPEN THE ABDOMEN

for opening the abdomen. To treat these patients by medication, such as calomel, phosphate of soda, etc., is not only a mistake, but prolongs the inflammation as well as favors complications, pericholecystic adhesions, etc. Medication or food by mouth excites gastric peristalsis and favors extension of the inflammation. I see this so often where insistence upon medical treatment has apparently won the day. On the other hand, the young or inexperienced surgeon is tempted to operate on these patients at once, a practice that will not give the best results. As I have already said the diagnosis is the guide, the deciding point as to when and when not to open the abdomen.

At the onset of the attack of simple acute cholecystitis it may not be possible to differentiate between the inflammation of an early acute, high-lying appendix and that of a gall-bladder, the pain in both being referred to the epigastrium, while the muscular resistance, due to the intraperitoneal irritation, or to a peritonitis with corresponding tenderness, renders palpation most unsatisfactory. We often meet this embarrassing situation, but after a few hours of the treatment already referred to, the intraperitoneal irritation will have diminished sufficiently to make the muscles overlying the inflamed area more flexible, so that the tips of the fingers can be carried deep enough to locate the point of greatest tenderness and perhaps feel the fundus of the gall-bladder by having the patient breathe rather deeply, but slowly, when it will be felt moving with respiration. This makes the diagnosis certain. In an appendicitis the line of tenderness will be in the line of the position of the appendix. In addition to these physical findings, the history is of most importance. In the case of one or the other of the ultra-acute varieties of cholecystitis, it must be remembered that acute perforation at the base of a high-lying appendix, acute perforated ulcer, acute intestinal obstruction, and acute pancreatitis enter the diagnostic picture.

In *subacute perforated peptic ulcer*, which is most often duodenal, the abdomen should *not* be immediately opened, and why not? First, this type of lesion is, in most instances, difficult to diagnose as it is not usually seen by the surgeon until two or three days, perhaps more, after its occurrence. Secondly, it is usually taken care of by a protective peritonitis, during the active stage of which operation has more hazards than if made when the peritonitis has subsided and the peritoneal cavity is well protected; in other words, coffer-dammed. In this latter stage particularly, a posterior gastro-enterostomy can be safely made without in any way disturbing the site of the lesion. These are not emergency cases, unless seen immediately after the perforation has taken place, when the diagnosis is not certain. Two possibilities, chiefly, confuse the situation—simple acute cholecystitis and acute terminal inflammation of a high-lying appendix, either of which, as in the case of ulcer, will subside if treated by anatomic and physiologic rest.

In instituting anatomic and physiologic rest, the usual procedure is to, first, wash out the stomach, but in the questionable ulcer case this had better not be done, for fear of increasing duodenal extravasation. If there is disturbing nausea, the introduction into the stomach only and retention of a

duodenal tube, drainage of the stomach contents will be of advantage and relieve the nausea. Aspirating the tube with a syringe will quickly empty the stomach. The contents of the duodenum at first are usually sterile. Later, however, from regurgitation of the contents of the upper small intestine, smear examination will show the presence of organisms of the colon bacillus group. This is the chief reason for early as against late operation in acute perforated ulcer.

A common abdominal catastrophe is *acute perforated peptic ulcer*, which, when once seen, can scarcely be forgotten, and when seen for the first time, unless the patient volunteers and gives a very typical history of ulcer, is more often than not misjudged. I see this beautifully exemplified in our clinic when the new interne comes on service, who, after he sees his first case of ruptured ulcer, rarely fails to recognize it. It is the exception for me to have to make the diagnosis, for it is already made when I am called by 'phone or the case comes in while I am in the hospital. The message is: "A perforated ulcer has been admitted."

The diagnosis is made by the history, if one can be elicited, and when this is not obtainable, by the sudden onset of acute abdominal pain making its appearance like lightning out of a clear sky, immediately followed by board-like rigidity of the abdominal walls that are tender, but not impressionable to touch. These patients maintain a more or less fixed position in bed, hoping by doing so that they will suffer less. This is a sign of moment. They are not shocked unless it is immediately after the occurrence of the perforation, before they reach the clinic, or before they are seen by the surgeon. They have a normal pulse and temperature, a dry skin, and a leukocytosis, an example of kindly nature which we are glad to see. As it is the family doctor who first sees the patient, it behooves him to be conversant with the lay of the land, and not to defer calling in the experienced surgeon at once, not this afternoon, this evening, or, perhaps, tomorrow, but immediately. It matters not whether the perforating ulcer is duodenal, gastric, or marginal, *there is only one road to the goal, and that is the operative route*. These patients should not die. All, barring a very few cases, will get well if operated within the first few hours, while they all will die if operated too late.

Why is this condition not recognized early? Because of the want of knowledge of the significance of muscular rigidity. Pronounced abdominal muscular rigidity is one of the easiest of the danger signals to read. I make this statement without fear of contradiction; except in the highly neurotic, hysterical individual it always means intraperitoneal irritation, the forerunner of peritonitis, whether caused by disease or by trauma. It is when these patients are not seen until late and there is a diffuse peritonitis with distention and the history is negative, that diagnosis is doubtful. In the majority of these cases there is a history of digestive trouble, consisting of pain one and a half to two hours after eating, which has been treated medically and

WHEN AND WHEN NOT TO OPEN THE ABDOMEN

pronounced cured. I know of many such cases, since it has been my privilege to have operated on more than two hundred acute perforated ulcers.

In the presence of a central upper abdominal swelling with overlying rigidity and exquisite tenderness occurring suddenly, particularly in an obese subject past middle life, who, besides being shocked, is more or less livid, with a small, rapid pulse, persistent retching, or vomiting, *acute pancreatitis* should be thought of, and the abdomen should be opened. This condition cannot be operated too early, but too late. Medication is absolutely useless. If, under these conditions, the abdomen is opened and nothing found, no harm results, while if too much is found, death results.

A condition with as dramatic an onset, but much less frequent than perforating peptic ulcer, is *mesenteric thrombosis*. It should be thought of in the following circumstances: Onset of most agonizing acute abdominal pain in a person past middle life with high blood pressure and sclerotic vessels. With few exceptions, the diagnosis is not possible without opening the abdomen, because of other conditions, such as torsion of the great omentum, acute intestinal obstruction occurring at the site of the foramen of Winslow, or through a congenital opening in the mesentery, or in one of the peritoneal fossæ. The last named, as a rule, occurs more often in young subjects. However, this matters little, as any of them constitutes an abdominal catastrophe and calls for immediate operation, otherwise the patient has no chance whatever to recover. These patients are all shocked, but this is no excuse for not immediately opening the abdomen. The indication for operation is vital on account of the rapidly oncoming gangrene and toxæmia. Those of us who have had experience in dealing with these conditions know too well the importance of immediate action. The gravity of the situation is extreme and does not permit of deliberation if the right thing is to be done.

To repeat, the outstanding points in these cases are: A person previously well, suddenly seized with most intense abdominal pain, immediately followed by depression, especially evident in the thrombotic patient, and diffused rigidity of the abdominal walls, which are extremely tender to the lightest touch. This syndrome is enough to warrant immediate intervention. Auscultation reveals stormy peristalsis early in the case, but later, when peritonitis is advancing, if it has not already advanced, peristalsis will be either diminished or entirely absent. A silent belly is ominous and too often spells death. Very early the pain is intermittent and paroxysmal, but later it becomes continuous, while lessening of the muscular rigidity and distention shows that the demon toxæmia is on the scene and dominates the situation, which means fatality.

Acute obstruction through a congenital rent in the mesentery is likely to follow heavy lifting and cannot be differentiated from torsion and strangulation of the great omentum *en masse*. I would also call attention to strangulation of a small portion of the great omentum, the diagnosis of which is impossible. Both of the latter conditions necessitate immediate abdominal incision.

Continuance of symptoms of obstruction following the reduction of what seems to be an incarcerated or a strangulated hernia indicates the immediate opening of the abdomen.

All of these possibilities, if kept in mind when approaching the victim of an acute abdominal seizure, will reduce the serious likelihood of error. Doctor Agnew said to me not long before his death, that if he could live twenty-five years longer—he had been practicing surgery for over fifty years—how much more good he could be to the surgically sick. Personally I feel as Agnew, my revered teacher, did. Surgical intuition or judgment, the greater part of which is horse-sense, counts for most. My father used to tell me when his patients were very ill and giving him great thought, he would go away for two or three days, when he would return home to find them better. I hope to transmit this thought to my son, now a member of the interne staff of our clinic.

In conclusion, I wish to refer to a few of the traumatic conditions in which the abdomen should be immediately opened, namely, *rupture of the liver, the spleen, the pancreas, the small intestine, and the bladder*. The severity of the symptoms and physical signs in these cases depend upon the extent of the injury. When the injury is slight, the evidence of shock, hæmorrhage and muscular rigidity is not so pronounced as in reverse conditions; however, the sign always present is muscular rigidity caused by intraperitoneal irritation. This alone justifies the immediate opening of the abdomen. In the presence of definite muscular rigidity if we act at once, and discountenance waiting and watching, we'll have no regrets but much joy. If I could know that you carry this away with you I should feel happy I came, for I have told you something.

To treat the patient for shock, to make a blood count, to observe the pulse, to infuse only to allow the infusion to escape through the torn vessels, is to court danger. The death rate in these conditions is much, much too high, and, I am sure, is due to dillydallying and not being sure of oneself. A recent case admitted to our clinic illustrates the importance of the presence of muscular rigidity immediately following severe trauma of the abdominal walls and of interpreting it as a danger signal.

No. 2572/28. A male, aged thirty-eight years, was admitted to the Lankenau Hospital September 20, 1928. While planing a board a machine struck the board which in turn struck the patient across the upper abdomen, causing a red streak at the site of the injury. This was followed soon after by epigastric pain which grew progressively worse as the patient was on his way to the hospital, about fifty miles distant from his home. On admission, September 20, 1928, he appeared much shocked, and there was marked abdominal rigidity.

Examination of the abdomen showed a line of abrasion across the upper abdomen, board-like muscular rigidity, and very marked pressure tenderness, so great that the patient could not stand the weight of the bedclothes. The blow apparently had struck him just over the site of the liver. Temperature, pulse and respiration were normal. Red blood cells and hæmoglobin normal. White blood cells 20,200, neutrophils 76, lymphocytes 18, large mononuclears 5, transitionals 1. A diagnosis of ruptured liver was made and immediate operation was decided upon and agreed to by the patient.

WHEN AND WHEN NOT TO OPEN THE ABDOMEN

Under spinocain anæsthesia I opened the abdomen through a right rectus incision. There was an immediate discharge of blood. An L-shaped rupture was found on the right lobe of the liver, anteriorly. This was sutured. Another rupture was found on the under surface of the liver, medial to the gall-bladder and running into the gall-bladder fossa. This necessitated a cholecystectomy. I also took out his appendix. Recovery was prompt and uninterrupted. Smears taken from a pool of blood in the subhepatic fossa were negative, proving that the traumatized field was sterile. Waiting in this case would have meant severe bleeding, primary anæmia, with the great risk of colon bacillus infection, and peritonitis and lessened chances of recovery by later operation.

This, as well as other cases operated promptly in the clinic, proves the correctness of our stand in the presence of marked rigidity, pain, etc. The citation of one other case, and I am done.

A boy, twelve years old, playing in the street, was knocked down by a passing wagon, the rear wheel of which passed over the abdomen. Fortunately, the accident occurred close to the hospital, so that only a short time elapsed between the receipt of the injury and admission to the clinic. There was pronounced pain and pronounced rigidity of the walls of the abdomen. I advised immediate operation, but the parents objected to this until their family doctor could be called. I waited for the arrival of the doctor, whom, fortunately, I knew very well, and whom I had no trouble in convincing that a serious intra-abdominal condition existed. I opened the abdomen, found the small intestines completely divided transversely, entailing an end-to-end union. Convalescence was rapid and uninterrupted.

The pronounced muscular rigidity forced me to take the stand I did. This holds good in all serious intra-abdominal catastrophies if the patient is seen early before the occurrence of an advanced peritonitis, or before he has been almost exsanguinated. There, I say look and act, do not watch and wait.

CONCLUSIONS

Do Not Open the Abdomen for

Visceroptosis.	Acute puerperal infection.
Diffused peritonitis until (by anatomic and physiologic test) localization sets in.	Acute simple cholecystitis.
Retroperitoneal lymphangitis, of the lower right abdomen.	Subacute perforated ulcer.
	Late sigmoidal diverticulitis.

Open the Abdomen for

Acute appendicitis before peritonitis sets in; or in the absence of a forbidding peritonitis.	Ruptured ovarian blood cyst.
Acute intestinal obstruction, including volvulus, intussusception, obstruction at the foramen of Winslow, through a congenital hole in the mesentery or in a peritoneal fossa.	Placenta prævia.
Mesenteric thrombosis.	Accidental hæmorrhage in the pregnant uterus.
Torsion of the great omentum.	Ruptured uterus.
Ruptured ectopic pregnancy.	Perforated uterus.
Ovarian tumor or uterine fibroid twisted on its pedicle.	Chronic pyosalpinx—gonorrhœal or post- puerperal.
	Hernia, incarcerated or strangulated.
	Ultra-acute cholecystitis.
	Acute perforated peptic ulcer.
	Acute pancreatitis.
	Traumatic abdomen.

THE TREATMENT OF INTESTINAL OBSTRUCTION

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RECENT studies in intestinal obstruction have established the fact that there occurs in pyloric and high obstruction of the small bowel characteristic changes in the blood and urine chemistry.¹ These findings have led to a better understanding of the pathology of this disease and have contributed a valuable adjunct to its therapy.

In 1913 D. P. D. Wilkie² emphasized the importance of recognizing two different types of intestinal obstruction. These he designated as simple obstruction and obstruction plus interference with blood supply. The work of Hausler and Foster³ and Gatch and his co-workers⁴ further emphasize the importance of these two types when considering the proper surgical treatment. It is, of course, obvious that different problems are involved in the two conditions. In the latter there exists the toxæmia of infection and tissue necrosis associated with gangrene of the bowel in addition to the obstruction. Gatch, Trusler and Ayers⁵ have recognized the importance of gaseous distention and have concluded that this distention alone may exert sufficient pressure to produce gangrene by occlusion of the circulation in the bowel wall, especially along the antimesenteric surface.

From these observations it is readily understood that intestinal obstruction cannot be rationally treated without some knowledge of its chemistry and pathology.

A discussion of the treatment of acute intestinal obstruction may well be divided into five parts, a recognition of which is essential for proper therapy. They are as follows:

1. Removal of the mechanical obstruction.
2. Relief of dehydration.
3. Relief of hypochloræmia.
4. Relief of starvation.
5. Drainage of the small bowel (enterostomy).

The importance of early diagnosis and surgical treatment of this condition has been emphasized since the subject first attracted the attention of medical writers. If recognized sufficiently early before alteration in the chemistry of the tissues and fluids, operation for the direct relief of the obstruction or strangulation will undoubtedly result in the cure of a high percentage of cases. Unfortunately, many cases are not diagnosed early and present themselves for treatment with the disease far advanced and much damage already done. It is this class of patients which require the utmost care in the choice of treatment. Each individual case must be carefully studied and a time selected for operation which will give the greatest chance of recovery. Almost all surgical textbooks state that operation should be

THE TREATMENT OF INTESTINAL OBSTRUCTION

done as soon as a diagnosis is made. This is undoubtedly dangerous teaching. To operate upon any patient to relieve a mechanical obstruction of the small intestine without taking into consideration the phases of treatment as listed is to treat the disease without understanding. The time for surgical relief of an obstruction is very variable and must depend upon the patient's condition. It may, with good judgment, be done only after the patient has received large quantities of water, salt and glucose to relieve the dehydration, hypochloræmia and starvation. To rush a patient to the operating room from the ambulance for a major operation is never justifiable when two or three hours of treatment will improve the risk.

Dehydration soon becomes extreme if the small intestine is obstructed. It has been estimated that in each twenty-four hours there is a normal secretion into the upper intestinal tract of gastric juice, bile, succus entericus and pancreatic juice amounting to from seven to nine litres. Dragstedt⁶ believes that these secretions are stimulated and increased by bowel obstruction. Wangenstein and Chunn⁷ report a case in which the measured liquid from the stomach and duodenum amounted to 6,000 cubic centimetres in twenty-four hours. Compared with the average intake of liquid, which is less than half this quantity, the loss is of great significance. Hartwell and Hoguet⁸ expressed the belief in 1912 that death in simple obstruction of the intestine is due to dehydration. Wilkie² also believes that the cause of death is dehydration. Gamble and McIver⁹ recognize the importance of water loss, but believe that the accompanying loss of the electrolytes, sodium and chlorine to be of greater significance. Hausler and Foster³ attribute death to starvation in uncomplicated cases. Gatch and his associates⁴ go a step farther and state that their investigations have led them to the conclusion that in simple obstruction of the intestine, without gangrene, there is no absorption of toxins sufficient to cause death, but death is due to dehydration, loss of chlorides by vomiting and starvation. The majority of authors in the past have attributed death to a toxin or toxins formed in the contents or wall of the obstructed gut. If dehydration, hypochloræmia and starvation are the only lethal factors, it is difficult to explain the rapid improvement following the drainage of the obstructed gut by enterostomy. Whether or not there is absorption of toxins from the obstructed and damaged gut is a problem for future researches to determine. At present one hardly seems justified in believing that the cause of death in acute intestinal obstruction has been proven.

With a knowledge of the fluid loss as indicated above it is easy to estimate the quantity of water necessary to recover water balance. During the acute illness no less than four to six litres of liquid should be given every twenty-four hours. In extreme cases this should be increased. No harm can be done if water is given as long as thirst exists.

Water should always be given as salt solution. We have found that distilled water given subcutaneously or through an enterostomy opening below the obstruction not only does not prolong but probably shortens life. This observation has recently been confirmed by Gatch, Trusler and Ayers.¹⁰

Without salt there can be no life. In the hypochloræmia of intestinal obstruction the administration of sodium chloride is an essential part of the treatment. The blood chlorides, estimated as sodium chloride, may be reduced as low or even lower than half the normal. As the disease develops there is a rise in the urea and non-protein nitrogen of the blood and usually a rise in the carbon dioxide combining power. Sodium chloride, given as salt solution, tends to restore the chemical changes of the blood to normal. Just what action sodium chloride has is problematical. We¹¹ early suggested that it might have a specific detoxicating action, but in the light of more recent work of others this explanation is doubtful. It is probable that the salt is necessary for the proper maintenance of water distribution and water balance of the body. Many other salts have been tried but none has been found that will replace sodium chloride in the reestablishment of normal blood chemistry.

In order to properly treat the hypochloræmia it is necessary to administer sufficient salt to return the blood chlorides to normal. This quantity, of course, varies with different patients and should properly be governed by frequent blood studies.

Before any operation is done every patient seriously ill with intestinal obstruction should be given preliminary treatment with salt solution. By using hypodermoclysis and intravenous injection three to four litres of water and fifty to seventy-five grams of sodium chloride may be given in two to four hours. Salt solution may be given safely in 2 per cent. solution under the skin and 5 per cent. in the vein if given very slowly. We recommend that about one hour be taken to administer intravenously 500 c.c. of a 5 per cent. solution. The delay in time necessary for this treatment is justifiable since it surely makes a better operative risk. After operation salt solution should be continued until the patient is out of danger. Usually four to six litres will be sufficient each twenty-four hours. It would seem logical to continue giving water and salt as long as the patient is thirsty and until the chlorides of the blood are within normal limits.

In those cases complicated by disturbed circulation and gangrene early operation is, of course, imperative to relieve strangulation or remove necrotic tissue. In such cases sodium chloride solution should be given in the same large quantities. Salt solution does not, however, have the same specific effect that it has in simple obstruction.

The need of food to furnish energy becomes an important factor after the patient has been ill for several days. It is advisable to begin the intravenous administration of glucose early in the disease and continue until the patient can take food by mouth. It may be given slowly in 10 to 25 per cent. solution. Experiments have shown that man can utilize from 0.8 to 0.9 grams of glucose per kilo of body weight per hour. This means that a patient weighing seventy kilos (154 pounds) could assimilate 56 to 63 grams of glucose per hour, furnishing about 200 to 250 calories of energy. Sufficient glucose may easily be given in twenty-four hours to produce 1,500 to 2,000 calories without harmful effect. The number of calories required for a

THE TREATMENT OF INTESTINAL OBSTRUCTION

seventy-kilo patient (154 pounds) at rest (asleep) is 1,680, which is equivalent to the basal heat production, or the smallest energy output compatible with health.

There is some difference of opinion in regard to the value of enterostomy in the treatment of acute intestinal obstruction. Victor Bonney,¹² McKinnon,¹³ Lee and Downs,¹⁴ Walker,¹⁵ Taylor,¹⁶ Wilkie,¹⁷ and C. H. Mayo¹⁸ all write convincingly of the value of jejunostomy. From the experimental evidence available, high jejunostomy is not done without danger. We¹⁹ have shown that simple drainage of the jejunum of the dog twelve inches below the ligament of Treitz will result in death in two to five days, with changes in the blood chemistry similar to those found in obstruction at the same level. Dogs may live indefinitely with drainage of the lower ileum. It is difficult to refute the clinical evidence in favor of high jejunostomy and further careful observation must be made to establish its true status. Enterostomy lower in the small bowel is of undoubted value in properly selected cases. Prompt relief from pain, nausea and a sense of oppression is often noted by the patient soon after the bowel is drained. A small percentage of cases will obtain complete relief in a few days; their bowels will begin to move and no further surgery will be necessary. Proper drainage of the gut will usually result if an upper left rectus incision is made and the first portion of small gut presenting is drained. Water and salt should, of course, be given in sufficient quantity in addition to the enterostomy.

The suggestion of Williams²⁰ that the toxæmia of intestinal obstruction may be due to the gas bacillus of Welch is an interesting observation. He concluded that beneficial results were obtained by treatment with specific serum for this disease. Further observation and experimentation will be necessary before a true estimate of Williams' contention can be made.

The value of human bile injected into the rectum as suggested by Brockman²¹ is also subject to proof.

CONCLUSIONS

1. From the operative standpoint obstruction of the small bowel may be divided into early and late simple obstruction and obstruction associated with circulatory disturbance or gangrene. In the early cases of simple obstruction immediate operation can be done with safety. In the late cases of simple obstruction operation should never be done without preliminary treatment of the dehydration and hypochloræmia. In cases complicated by strangulation of the gut or gangrene early operation is imperative, but may with great benefit be preceded by salt solution treatment.

2. Dehydration and hypochloræmia play major rôles in death due to intestinal obstruction. In every case sufficient salt solution should be given as rapidly as possible to correct these two conditions.

3. Distilled water should never be used alone. Experimental evidence has shown it to be not only useless but dangerous when introduced in large quantities under the skin or by enterostomy opening.

ORR AND HADEN

4. Intravenous administration of glucose in 10 to 25 per cent. solution is of great value in furnishing energy. It may be given with the salt solution.

5. Enterostomy as a preliminary operative treatment is of undoubted value in selected cases. It should not be depended upon to the exclusion of water and salt.

6. Treatment of intestinal obstruction with Welch bacillus antitoxin or human bile by rectum requires further investigation to establish its value.

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AN ANATOMICAL AND CLINICAL STUDY OF INFECTIONS OF THE HAND

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THE substance of this article is the result of injections of eighty-four hands in the anatomical laboratory with ten per cent. gelatin to which had been added a few cubic centimetres of formalin. To this has been added the clinical experience of the writer. Particular emphasis has been placed upon the spaces around the lumbrical and interossei muscles. Naturally, like other studies of infections on the hand, the stimulus has been the work of Kanavel.

An attempt has been made in the succeeding illustrations to give a clear anatomical conception of where and how these major infections take place, and with this knowledge it is possible to better diagnose, prognosticate and treat the various infections.

It is important to get the point of entrance of the infection since then there is a possibility and probability that the course and spread of the infection may be determined. Too much emphasis cannot be placed upon the examination of each finger and area of the hand carefully and separately.

In a thenar space infection there is tenderness over the area of the thenar space. This area is usually distended on the palmar surface and usually on the dorsal aspect of the web between the thumb and index finger. Extension of the index finger usually results in pain.

Mid-palmar space infection gives tenderness over this area with or without loss of concavity of the palm. There is pain on extension of the middle, ring and usually the little finger.

Infection of the short tendon sheaths of the index, ring, and middle fingers results in a diffuse swelling and redness of that digit with tenderness limited to the anatomical outline of that sheath. The finger is held in a slightly flexed position and there is excruciating pain on extension. When the blind proximal end of the sheath ruptures into the thenar or mid-palmar space there are the added signs of these space infections.

In infections of the synovial sheath of the flexor longus pollicis (radial bursa) there is swelling and redness over the thumb with tenderness over the anatomical outline of the bursa. On extension there is considerable pain and tenderness over the flexor surface of the wrist.

In infection of the ulnar bursa there is swelling and redness of the little finger with excruciating pain on extension. Hand is semi-flexed at the wrist; usually all fingers, and many times the thumb, are partially flexed. There is tenderness over the anatomical distribution of the bursa.

Treatment for infections of a tendon sheath or fascial space is incision and drainage, thin rubber-dam or a piece of rubber glove should be used for



FIG. 1.—Diagram showing the positions of the mid-palmar and thenar spaces. The thenar space is to the radial side of the mid-line of the middle finger and extends distally to about a thumb's breadth of the web and proximally to about two thumbs' breadth of the wrist flexion crease. The mid-palmar space is to the ulnar side of the mid-line of the middle finger and extends distally and proximally as the thenar space (after Kanavel).

INFECTIONS OF THE HAND

drainage material as it causes less trauma. Many times no drainage material is necessary. A large voluminous wet dressing is then applied extending from the hand to above the elbow. Hot boric acid solution is used and should be reapplied every two hours. During the interval the dressing is surrounded



FIG. 2.—The skin and superficial fascia have been removed from the palm of the hand, exposing the palmar fascia which fans out to the base of the fingers. In the webs the fascia is thinner and the blood vessels and nerves may be seen through this layer.

by hot water bottles or a dry heating apparatus, such as a large electric light bulb. Since rest is most important in the early stages it is well to splint the arm in a large pillow. The wet dressings are continued for two to four days and then the hand soaked in hot boric solution, two to three times a day for

about one-half hour, followed by dry heat for one hour beneath the cradle or other heating apparatus. While the hand is in the hot soak and under the dry heat, both active and passive motions are encouraged. In infections of the hand the position of function as emphasized by Kanavel and Koch must always be kept in mind; that is dorsiflexion of the wrist, flexion of the



FIG. 3.—The palmar fascia has been removed, exposing the flexor tendons, the superficial palmar arch and branches of the ulnar and median nerves. The radial bursa is a synovial sheath around the flexor pollicis, longus tendon. The ulnar bursa is a synovial sheath around the flexor tendon to the little finger. The mid-palmar and thenar spaces lie deep to the structures shown in this plate. There are four lumbrical muscles, each having origin on a flexor tendon and passing around the radial side of the finger insert on the extensor tendon over the proximal phalanx.

fingers, as in grasping a ball, and abduction of the thumb so as to have the palmar surface of the thumb face the palmar surface of the index finger. Baking and massage, active and passive motion are then continued through convalescence. Too much emphasis cannot be placed upon the treatment during this period of recovery.

Return of function in fascial space infection is usually very good, but synovial sheath infection can never be expected to reach 100 per cent.

INFECTIONS OF THE HAND



FIG. 4.—The flexor tendons, with the superficial arch and branches of the median and ulnar nerves, have been removed, exposing the floor of the mid-palmar and thenar spaces. The deep palmar arch is exposed. The floor of the mid-palmar space consists of the interossei muscles. The floor of the thenar space consists of the adductor muscles.



FIG. 5.—Gelatin injected into the radial side of the mid-line of the middle finger by thrusting the needle through the palm, showing how pus collects in the thenar space between the thumb and index finger, and over the adductor muscles. The lumbrical muscle and flexor tendon of the index finger have been pulled toward the mid-line. Pus may travel around the border of the adductor muscle in the web and appear on the dorsum between the thumb and index finger.

INFECTIONS OF THE HAND



FIG. 6.—Gelatin injected into the radial side of the mid-line of the middle finger by thrusting the needle into the palm, showing how pus only extends to the mid-line of the middle finger. Under sufficient pressure it may break through the connective tissue barrier and into the mid-palmar space. However, this seldom occurs because it is usually rather early diagnosed by the swelling over the thenar area and on the dorsum between the index finger and thumb. The flexor tendon of the index finger has been removed.



FIG. 7.—Gelatin injected into the ulnar side of the mid-line of the middle finger by thrusting the needle through the palm, showing how pus collects in the mid-palmar space. The flexor tendons and lumbrical muscles of the middle, ring and little fingers have been removed. Pus is extending distally along the lumbrical muscles (lumbrical spaces) toward the radial side of the fingers.

INFECTIONS OF THE HAND



FIG. 8.—Gelatin injected into the ulnar side of the mid-line of the middle finger by thrusting the needle through the palm, showing how pus collects in the mid-palmar space and under increasing pressure may break through the connective tissue barrier to the thenar space. The flexor tendons are still intact.



FIG. 9.—This is the preceding experiment with the flexor tendons removed, showing how pus may break into the thenar space and extend distally along the lumbrical muscles (lumbrical spaces) and through the web and onto the dorsum of the proximal phalanx.

INFECTIONS OF THE HAND



FIG. 10.—This is the dorsum of the hand in the preceding experiment, showing how pus has traveled along the lumbrical muscles (lumbrical spaces) on the radial side of the middle, ring and little fingers to reach the dorsum of these fingers over the proximal phalanx.

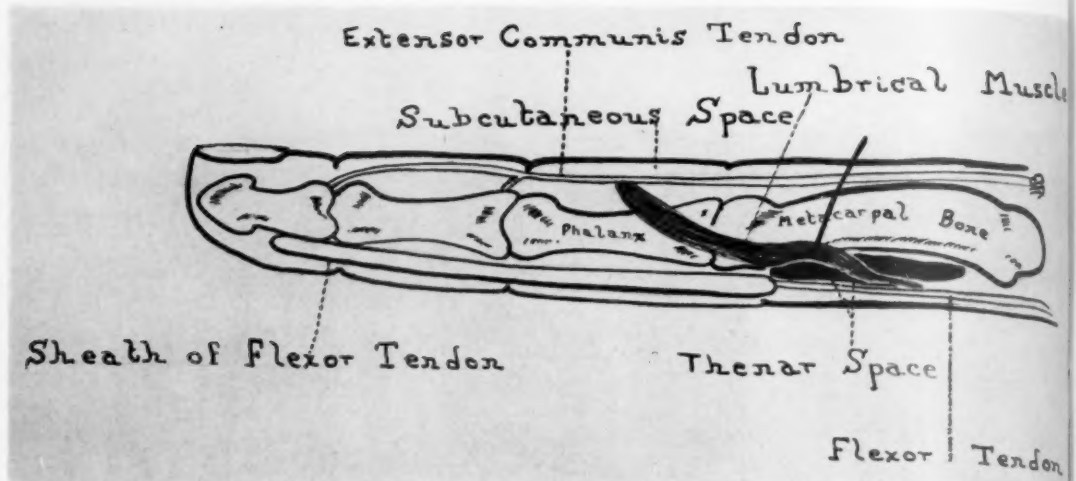


FIG. 11.—Diagram showing the relation of the lumbrical muscles to the dorsum of the proximal phalanx and a thenar or mid-palmar space. The lumbrical muscle (hooked up) arises from the flexor tendon over the mid-palmar or thenar space and extends distally around the radial side of the base of the finger to insert on the extensor tendon over the dorsum of the proximal phalanx. This shows how pus may extend from the palm and appear on the dorsum of the proximal phalanx and web as shown in Fig. 10. Infection may also travel from the dorsal subcutaneous space along the lumbrical muscle to the palm. Diagram also shows how the flexor tendon sheaths of the index, middle and ring fingers end blindly at the thenar or mid-palmar space and in close relation with the lumbrical muscle (space).

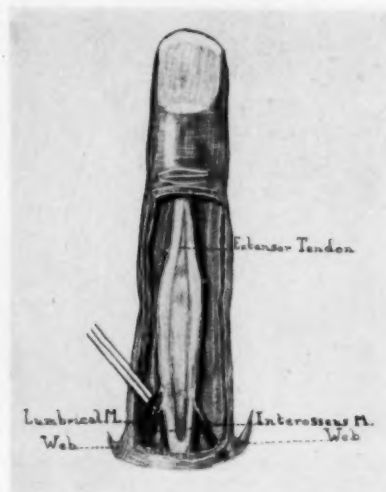


FIG. 12.—The lumbrical muscles of the index, middle, ring and little fingers pass around the radial side of the base of these fingers and insert over the dorsum of the proximal phalanx into the extensor tendon and its fibrous expansions. Volar and dorsal interossei muscles pass around both sides of the base of the fingers and insert on the extensor tendon and its fibrous expansions. Around the interossei muscles and particularly the lumbrical muscles on the radial side of the base of the proximal phalanx are areas of rather loose connective tissue where infection and pus in the region of the proximal phalanx may extend into the web. This explains why infections in this region are prone to heal slowly because of insufficient drainage of these lumbrical and interossei spaces.

INFECTIONS OF THE HAND

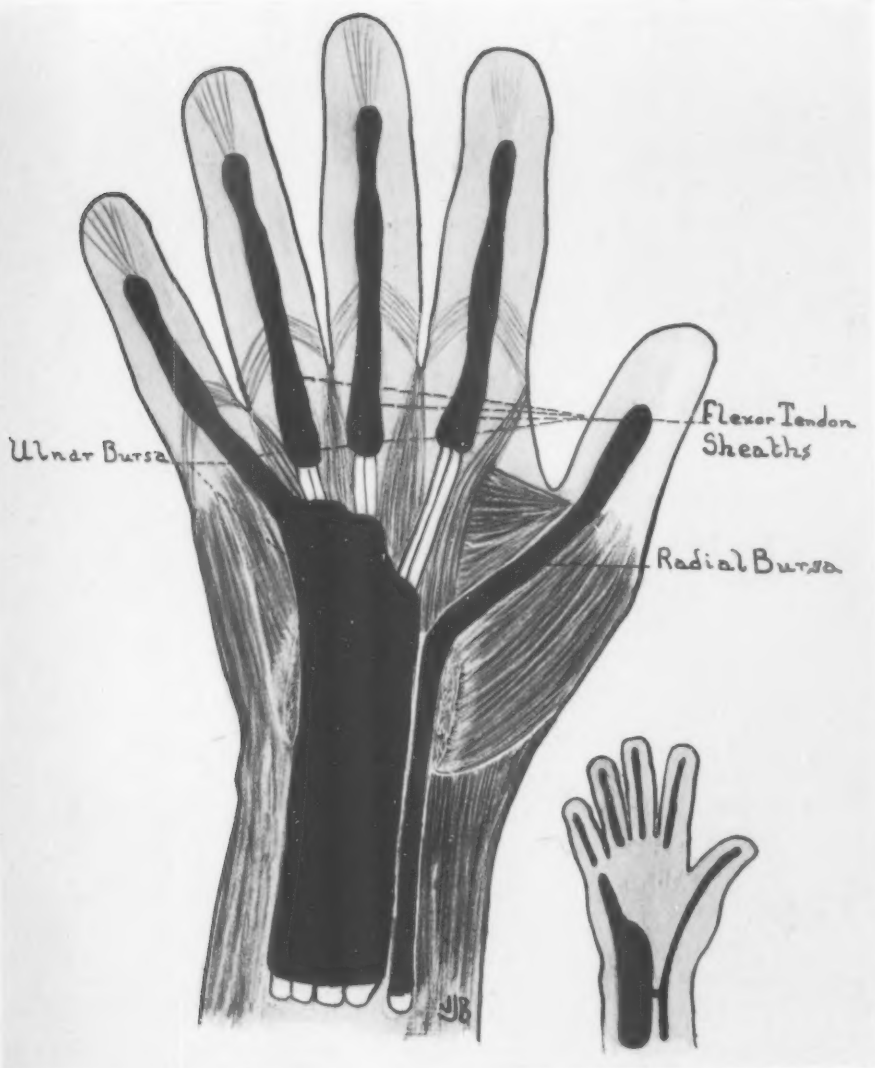


FIG. 13.—Diagram similar to those in textbooks showing the tendon sheaths. Every tendon has a fibrous sheath but only those tendons have a synovial sheath where there is an intricate mechanism or considerable motion and friction. The flexor tendon sheath (radial bursa) of the thumb extends about two thumbs' breadth above the flexion crease of the wrist. The flexor tendon sheath (ulnar bursa) of the little finger extends about two thumbs' breadth above the flexion crease of the wrist. It envelops the tendons of the other fingers beneath the transverse carpal ligament forming a large intercommunicating bursa or divides into several independent noncommunicating bursæ. The tendon sheaths of the index, middle and ring fingers extend about a thumb's breadth above the base of the finger. The small diagram shows the communication between the ulnar and radial bursæ which is present in about 60 per cent. of cases, and explains the frequent traveling of infection between these two bursæ. In about 25 per cent. of cases there is a break in the continuity of the ulnar bursa over the base of the little finger as shown in the smaller drawing.

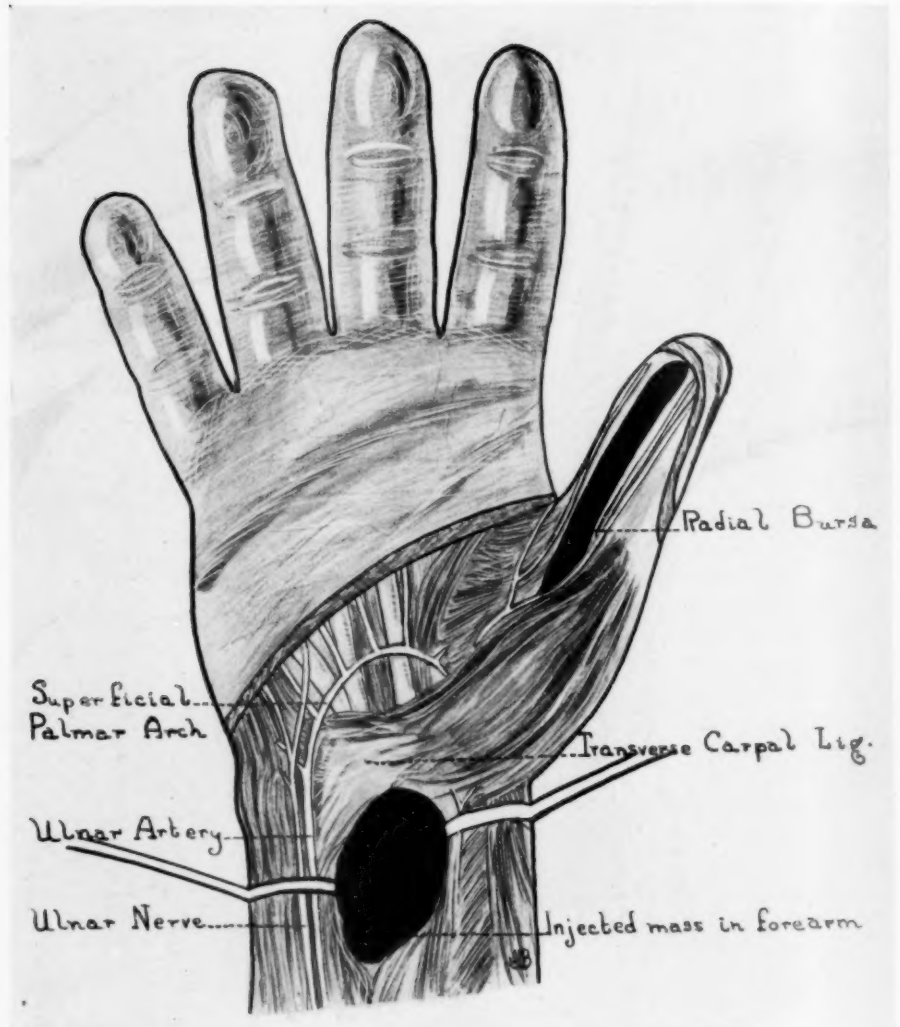


FIG. 14.—Gelatin injected into the synovial sheath (radial bursa) of the flexor pollicis longus tendon and shows how pus may extend proximally along the bursa and under sufficient pressure may rupture into the forearm deep to the flexor muscles and over the pronator quadratus muscle. The flexor tendons have been separated, exposing the mass in the forearm.

INFECTIONS OF THE HAND



FIG. 15.—Gelatin injected into the flexor tendon sheath of the index finger, showing how pus under sufficient pressure may rupture through the blind proximal end of the sheath into the thenar space. The flexor tendon of the index finger has been removed.



FIG. 16.—Gelatin injected into the flexor tendon sheath of the middle finger, showing how pus under sufficient pressure may break through the blind proximal end of the sheath into the mid-palmar space. Only occasionally has this sheath ruptured into the thenar space. The flexor tendons of the middle, ring and little fingers have been removed.

INFECTIONS OF THE HAND



FIG. 17.—Gelatin injected into the flexor tendon sheath of the ring finger, showing how pus under pressure may break through the blind proximal end into the mid-palmar space. The flexor tendons of the middle, ring and little fingers have been removed.

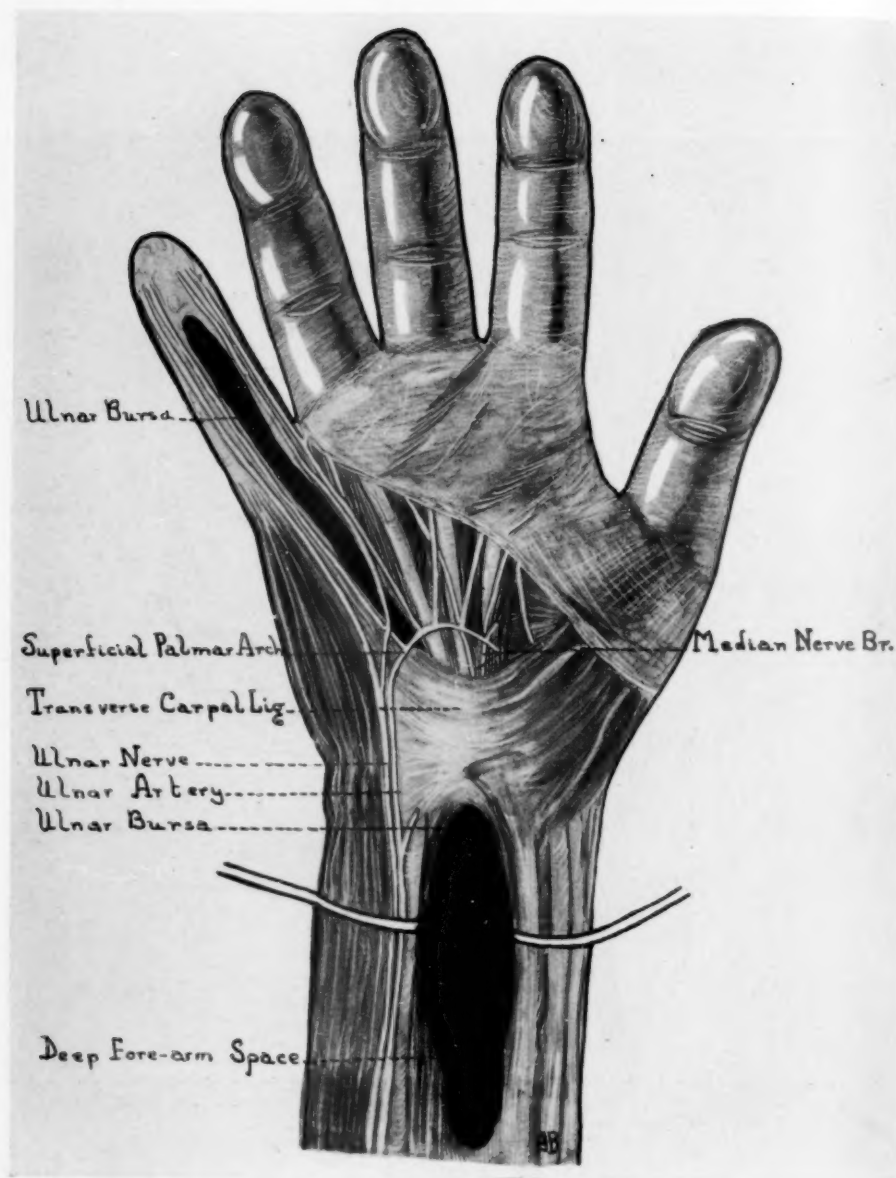


FIG. 18.—Gelatin injected into the ulnar bursa, showing how pus travels proximally in the bursa and under sufficient pressure breaks into a space just above the wrist and deep to the flexor tendons and over the pronator quadratus muscle. The flexor tendons have been separated to expose the mass deep in the forearm.

INFECTIONS OF THE HAND



Fig. 19.—Diagram showing incisions for drainage of the ulnar and radial bursae and synovial sheaths of the fingers. Incision for the radial bursa begins over the proximal phalanx, extends upward and medially keeping just to the medial side of the thenar eminence since the bursa is overlapped by the thenar muscles. Incision should only extend to within about two thumbs' breadth of the wrist flexion crease because of a motor nerve to the thenar muscles crossing the bursa at this level. The incisions for drainage of the synovial sheaths of the fingers should be on the lateral surface and interrupted over the interphalangeal joint so as to prevent prolapse of the tendon and a resulting bowstring deformity. If the ulnar bursa is infected the little finger is incised as above and the bursa further drained by an incision beginning near the web and keeping to the medial side of the hypothenar eminence and extending proximally to about a thumb's breadth below the flexion crease of the wrist so as to avoid injury to the superficial palmar arch. However, at times it is necessary to extend this incision somewhat higher. The communication between the ulnar and radial bursae is present in about 60 per cent. of the cases, and incisions of both bursae may be necessary. The incisions on the forearm are for drainage of the upper ends of these bursae and the deep forearm space from rupture of the proximal blind ends of the radial or ulnar bursae. These incisions are made on the ulnar and radial sides of the forearm, respectively, keeping forward of their outer surfaces and beneath the flexor tendons so as to establish through and through drainage. Care is necessary with incision on the radial side to avoid injury to the radial artery.



FIG. 20.—Diagram showing lines of incision for drainage of the thenar and mid-palmar spaces. The thenar space is drained by an incision in the web between the thumb and index finger, as seen on both the large and the upper small drawing. After incising skin and fascia the adductor muscle is exposed as a band between the base of the thumb and index finger. By going to the palmar side of this muscle band with a blunt forceps the thenar space is opened. It is well to open the space to the dorsum, as pus in the thenar space usually travels around the free edge of the adductor muscle to the dorsum. The mid-palmar space may be opened by an incision beginning at the web and extending proximally about one inch between either the middle and ring fingers or ring and little fingers, or both. The lumbrical space may be further opened by extending the incision along the radial side of the proximal phalanx as shown in the lower small drawing. The incision for drainage of the lumbrical and interossei spaces is shown in the lower small drawing.

STRICTURE OF THE MALE URETHRA

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A HIGH morbidity and a relatively high mortality renders stricture of the urethra of prime importance among surgical lesions of the urinary tract. Stricture may occur in either sex and, depending upon its etiology, at any age. In a recent study of 1538 cases of surgical lesions of the male urethra admitted to the Urological Service of Bellevue Hospital, from April 1, 1910, to January 1, 1928, we discovered that stricture was the principal or underlying surgical disease in over three-fourths of these patients. Because of the relatively long period of time covered by this study, these patients were treated by many different operators and, with urological advances, some changes in the routine pre-operative, operative and post-operative measures have been made. Of great importance was the introduction of the phenolsulphone-phthalein renal function test and the routine use of chemical analysis of the blood. Of great satisfaction has been the development in recent years of spinal anaesthesia in preference to general anaesthesia for urethral surgery. All phases of stricture as observed in 1244 males are here presented. Particular interest focuses on treatment and its results.

Etiologically stricture may be classified: 1. Spasmodic. 2. Congenital. 3. Acquired:—Traumatic. Inflammatory.

Spasmodic stricture is neurogenic in origin, caused by contraction of the compressor urethræ muscle, occurs in the membranous urethra, and is cured by over-dilatation. De Bovis¹ has reported two cases of spasmodic stricture of the anterior urethra but we have not recognized an instance of this condition. Strictly speaking, however, spasmodic stricture is but the symptomatic expression of an irritation reflex. There may be an associated organic stricture.

Congenital stricture is usually asymptomatic and located chiefly at or just within the meatus. Of the two locations, the latter $\frac{1}{2}$ to 1 cm. within the urethral orifice is the most common, and congenital strictures here are often extremely dense. The presence of these lesions is made known by the acquisition of a urethritis which will not be cured until the stricture has been cut or dilated to normal calibre. In our series but one stricture was determined to be definitely congenital. This was cut.

According to the statistics of others, traumatic stricture constitutes 5 to 10 per cent. of urethral obstructions excepting those of the prostate. We found but twenty-three (1.9 per cent.) such cases among the 1244. While clinically traumatic stricture is more rapid in development and therapeutically more obstinately tenacious than inflammatory stricture, the treatment is the same as

applied to the latter though prolonged, and, as a rule, traumatic strictures require cutting. The membranous urethra is most frequently involved for here are received the crushing blows of the so-called "straddle injuries" of the perineum.

Over 90 per cent. of urethral strictures are of inflammatory origin; the gonococcus is predominately the invading organism. It is primarily with this type of stricture that we are here concerned. Gonococcus infection was denied in sixty cases but one tends to consider this as faulty diagnosis or bare falsification since in some of these gonococci were subsequently revealed.

Etiology.—By definition, a urethral stricture is a pathological diminution of the lumen or of the distensibility of this canal. Normally the calibre of

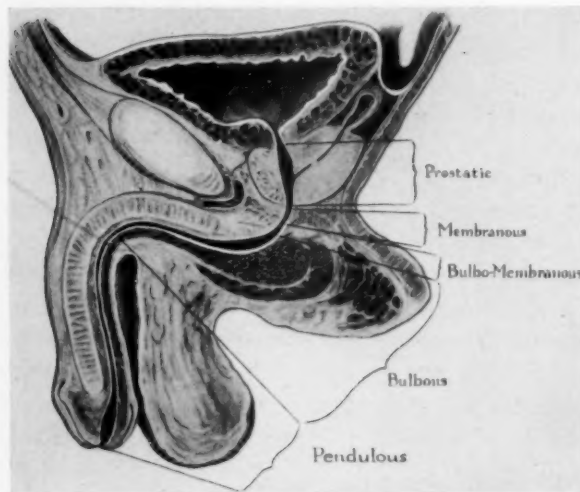


FIG. 1.—Normal variations in calibre of male urethra. Dilatations of anterior (fossa navicularis), deep bulbous and prostatic urethra are noteworthy. The subdivisions of the urethra as designated clinically are indicated. In our series the location of the stricture of maximum intensity as revealed by examination or operation follows: Pendulous urethra 242, bulbous 206, bulbo-membranous 247, membranous 99, prostatic none.

the channel is not like a straight tube as conceived by Otis, but varies greatly with definite anatomical constrictions and dilations. (Fig. 1.) While there is no universally accepted form a 30 F. sound may be passed through most non-inflamed adult urethra without difficulty. For some surgeons, a constriction having a calibre of 23 F. or less constitutes a stricture (Oberlander²); for others, but what is essentially the same, a scar of sufficient degree to grasp a 26 F. sound (Keyes³). It is usu-

ally observed that a stricture which will offer the characteristic obstruction or "hang" to an olivary bougie of calibre 23 F., for example, will require the passage of a much larger sound before grasping is elicited.

The histology of the urethral lumen goes far in explaining certain phases of stricture, particularly its sites of predilection. Columnar and cylindrical epithelium is an unusually good breeding ground for gonococci. It lines the urethra from the external meatus to the membranous portion where transition to infection-resistant squamous epithelium (continuous to prostatic urethra and bladder) occurs. Because of this resistance to infection and the absence of glandular structures in the membranous urethra, stricture in this location is less frequent. On the other hand, the innumerable glands and crypts interspersed among the columnar cells offer favorable habitat for inflammatory foci, notably in the bulbous urethra.

The inflammatory process alone rarely causes stricture; the latter seldom

STRICTURE OF THE MALE URETHRA

follows a well-treated gonorrhœa. Too forceful injections, the injection of hyper-irritating solutions, the unskilful passage of instruments or the breaking of a chordee are common trauma which serve but to intensify and prolong the inflammatory process. To quote Keyes, "the man behind the gun is more important than the solution in it."

Broadly speaking, stricture is a disease of the fourth, fifth, and sixth decade. Though the gonorrhœa be acquired early in life, the stricture does not usually manifest itself symptomatically until months or years later. Practically three-fourths of our patients were between thirty and sixty years of age, the youngest was sixteen, the oldest ninety-one. (Table I.) Over one-half had but one attack of gonorrhœa (Table II), and in this group we may gather rather accurate data indicating the relative latency between the acute infection and the appearance of stricture symptoms. It will be noted that of the 714 having had but one attack, 119 developed symptoms of stricture within one year or less. The shortest interval was one month. Five developed symptoms of strictures within two months. (Table III.)

TABLE I.

19 and under.....	6
20-29.....	203
30-39.....	275
40-49.....	296
50-59.....	251
60-69.....	134
Over 70.....	43
Not recorded.....	36
	1244

TABLE II.

Incidence of Gonorrhœal Infection.

Denied.....	60
Number of infections	
1.....	714
2.....	142
3.....	42
4.....	23
5.....	14
Several.....	42
Had.....	9
Present now.....	39
Not recorded.....	157
	1242

TABLE III.

Time Relationship Between Gonorrhœa and Initial Stricture Symptoms.

	Years							
	Under 1	1	2	3	4	5-9	10-15	Over 15
One attack only.....	27	92	43	32	35	29	133	299
First G. C.....	1	1	4	7	81	41	52	101
Last G. C.....		43	27	15	20	44	31	31

MEREDITH F. CAMPBELL

A great number of our patients suffered several attacks of gonorrhœa, and it is quite impossible to determine with accuracy when the stricture began although a history of repeated attacks presses one to the conclusion that stricture followed the initial inflammation and many, if not all, of the succeeding infections were flareups. (Table III.) Two patients alleged to have had twelve gonorrhœa infections each.

Of great interest, particularly in shedding light on the prognosis after operation, was a group of 348 stricture cases who had been operated upon previously—317 once, and thirty-one, two or more times. One patient had had nine urethrotomies performed. Three had had previous operations for urinary extravasation, twenty-nine had been operated on for periurethral abscess, and one for prostatic abscess. A large number, not indicated in the tabulations, had had sounds passed intermittently over variable periods of time but had ceased this precaution when contracture of the scar made instrumentation difficult or painful. (Table IV.)

TABLE IV.
Previous Operations for Urethral Stricture.

Times operated	
1.....	317
2.....	20
3.....	7
4.....	2
7.....	1
9.....	1
Interval since operation	
Less than 2 years.....	60
2 to 4 years.....	72
5 to 6 years.....	33
7 to 10 years.....	65
Over 10 years.....	101
Not stated.....	17
With associated periurethral abscess.....	29
For prostatic abscess.....	1
For extravasation of urine.....	3

Pathology.—The pathology of urethral stricture is that of chronic urethritis plus scar formation. This was carefully worked out by Oberlander. He found that with the transformation of the acute to chronic urethritis the following changes occur:

1. Organization of the periglandular inflammatory exudate into scar proportional to the severity of the inflammation.
2. If the glandular exudate can drain into the canal, intraglandular or intracryptic inflammation continues as a chronic catarrh (glandular urethritis of Oberlander); if the gland orifices are plugged by firm exudate, a glandular abscess or colloidal cyst is formed (dry urethritis of Oberlander). Further, the gland may be obliterated by scar or may return to normal.
3. The mucosa remains chronically inflamed. Oberlander designated

STRICTURE OF THE MALE URETHRA

as soft infiltration that lesion which urethroscopically appears as a reddened mucosa dotted by still more red suppurating duct orifices and with slight sclerosis of the walls indicated by diminution of the normal folds and urethral striæ.

The next stage or hard infiltration of Oberlander is characterized urethroscopically by loss of striæ or folds, a rigid urethral wall against the striking pallor of which the reddened orifices of inflamed glands stand out in sharp contrast. There may be erosions, ulcerations, granulations or papillomata. Increased scar formation with resulting anæmia explains the mucosal pallor. Infection accounts for ulceration and erosion while various stages of the repair process produce granulations and, if exaggerated, papillomata.

Intensification of this latter process, the hard infiltration of Oberlander, results in the condition we observe clinically as stricture.

In the transition from chronic urethritis to clinical stricture the Finger-Gujon theory assumes the urethritis to be always a sclerotic process, the degree of stricture being proportional to the duration of the inflammation. Since sclerotic repair is proportional to the severity of the inflammation and we do see stricture developing in a period of weeks in the presence of unusually acute urethral infections whereas chronic urethritis may persist for years without stricture formation, Guiard's theory—that stricture is dependent upon the severity of the localized infection—may be universally applied.

Clinically and pathologically, traumatic strictures are usually single. On the other hand, gonorrhœal strictures are often multiple. For while pathologically a lesion may appear as a broad band of scar, let a bougie à boule be passed through this sclerosed canal and a series of ridges will be noted. Urethroscopy may likewise reveal a series of constrictions. When multiple, it will be observed that the innermost stricture is usually the tightest and because of repeated assault and pressure of the urinary stream against this barrier, the urethra is dilated behind it. At the site of stricture, inflammation is increased and not infrequently intense glandular and periglandular abscesses develop. These may remain localized or may invade the corpus spongiosum and spread beneath or rupture through the skin, or rupture into the urethra—the clinical picture of periurethral abscess. This latter process may ensue at any point along the urethra with or without the presence of stricture, but when stricture is present, the constricted area is the site of predilection for abscess formation. On longitudinal section, the strictured urethra may present anything from an isolated constriction to a series of circular scars extending from the meatus to the prostatic urethra. There may be granulations, polypoid overgrowths of squamous epithelium which has replaced ulcerated columnar, or various knotty areas of scarring often with associated abscesses may infiltrate the corpus spongiosum and be externally palpable. Such swellings we noted on physical examination thirty times in the anterior urethra, fifteen times in the anterior bulbous, and seventy-five times in the perireal urethra.

With prolonged obstruction, urinary back pressure causes dilatation of the

proximal organs and eventually urinary sepsis intervenes. The deep urethra becomes pouched, the bladder wall hypertrophied, sclerosed, later atrophic and often the site of acute inflammatory ulceration. The upper urinary tract damage is most vital. The ureters may become dilated six to ten times their normal calibre, atonic and sclerotic. Renal injury is proportional to the

TABLE V.
Frequency of Urination.

	Times					
	1-2	3-4	5-6	7-10	Over 10	"Many"
Day.....			142	62	118	124
Night.....	129	137	109	24	59	120
						Involuntary
						70
						71

degree and duration of the obstruction, and may jeopardize life. It is, therefore, in terms of renal function that we consider stricture, both therapeutically and as to prognosis. In some cases of long standing we have found the renal function to be practically nil and autopsy has revealed hydropyonephrosis with no grossly discernible renal cortex.

Stricture of the prostatic urethra follows gonorrhoea only in association with other strictures anteriorly. As an isolated lesion it most often follows fracture of the pelvis with laceration of the prostatic canal. Strictures of the membranous urethra are almost always traumatic in origin. The most common site of inflammatory stricture is the bulb and bulbo-membranous urethra. In this study the urethra has been divided into the five arbitrary divisions we have been accustomed to employ clinically at Bellevue: penile or pendulous, bulbous or scrotal, bulbo-membranous, membranous or deep, and prostatic.

To be strictly anatomical these divisions are incorrect. Anatomists divide the urethra at the junction of the bulbous and the membranous portions into (1) anterior, (a) pendulous or penile extending from the external meatus to the suspensory ligament, (b) bulbous or scrotal from the suspensory ligament to the posterior boundary and (2) posterior, consisting of the membranous and the prostatic segments, the apex of the prostate subdividing these. Unless one is fortunate in performing a satisfactory perineal dissection and is able to recognize distinctly the anatomical landmarks at operation (quite hopelessly impossible in the presence of marked perineal periurethral infection or phlegmon), it is far more convenient clinically to designate as the bulbo-membranous urethra that short segment comprising the terminal bulbous and the beginning membranous urethra which is so often the site of intense sclerosis. This has been our practice at Bellevue; we are aware that this designation is used by others. The location of the stricture causing the greatest obstruction as revealed by instrumentation, endoscopy or operation is indicated in Figure 1. Often the strictures were multiple; in such instances the deepest has always been considered the most flagrant.

STRICTURE OF THE MALE URETHRA

Symptoms.—The recognition of many surgical diseases and their surgical treatment is recorded in the medical literature of antiquity. Not so with stricture. Probably the earliest essay on this subject is that of John Read published in 1588.⁴

As a rule the symptomatic onset of stricture is insidious. Although unnoticed by the patient, the continuous urinary obstruction slowly brings about a variable degree of urinary tract stasis and dilatation with accompanying infection. Later appear the definite clinical signs and symptoms so characteristic of urosepsis. While this is going on more active symptoms become manifest.

It is interesting to note how many years some patients have neglected themselves after the appearance of urethral symptoms. For years, many have been fully aware of the nature of their lesions. The duration of symptoms as elicited by history are shown in Table VI.

TABLE VI.
Duration of Symptoms of Stricture.

	Acute retention	"Stricture"	Urinary difficulty	Diminished stream	Dribbling
Days					
1.....	6		8	2	8
2.....	2		2	2	7
3.....	20		8	8	7
4.....	2		11	8	7
5.....	10		7	3	
6.....	3		1		1
Weeks					
1.....	28		25	14	5
2.....	9		18	12	6
3.....			13	7	7
Months					
1.....			13	11	6
2.....		149	14	18	9
3.....			11	12	9
4.....		61	13	11	1
5.....			1		2
6.....			17	15	8
7-12.....		87	9		
Years					
1.....			34	37	10
2.....		124	34	25	13
3.....		69	21	27	6
4-5.....		99	13	10	5
6-10.....		136	75	50	11
11-15.....		61	37	18	2
Over 15.....		101	23	12	5
"Years".....		171		9	
Present.....			325	276	136
Chronic retention.....	29				

Diminution of the urinary stream and its corollaries—urinary difficulty and dribbling are, as a rule, the first symptoms noted. The tightening stricture and faulty accelerator urethral muscle action resulting from periurethral sclerosis in the corpus spongiosum causes the last few drops to be withheld in the canal. This urine subsequently gravitates into the clothing. Changes

in the urinary stream other than diminution and irregularity are not suggestive of stricture. The legendary forked stream so generally associated in the minds of many with stricture is dependent entirely upon the conformation of the meatal nozzle. Adherent mucus may bring this about.

The persistent urethral discharge or gleet which accompanies most strictures is the symptom to first arrest the attention of many and cause them to seek treatment. While unquestionably present even more often, it was noted in this series 194 times. Too, when discharge is not grossly evident, the voided urine will always contain shreds in the presence of stricture. A shred is discharge.

Frequency, unless marked, causes little concern. A few complained because nocturia disturbed sleep. We noted furthermore that practically all patients urinating more than five times a day, voided at least once during the night. (Table V.) Associated prostatitis with vesicle neck irritation, cystitis, and renal congestion with polyuria are chief of the known cases of this frequency. With all strictures there is associated prostatitis.

Hæmaturia heralded the presence of stricture in but three cases. By its rarity here, this is quite in contrast to the findings of many. In 121 cases gross hæmaturia was noted at some period of the disease. Urinalysis revealed blood in 231. Unquestionably due to instrumental trauma in many cases, bleeding from urethral ulceration, granulation, polyps or erosions accounts for hæmaturia in the remainder.

Pain or burning on urinating was noted 394 times and was most often described as scalding in character. Usually of prostatic origin, it may be most intense at the bladder neck but may be localized at the frenum, in the perineum, or along the urethral canal.

Nodules of sclerosis along the course of the urethra (exclusive of clinical periurethral abscess) were noted by 170. Doubtlessly many of these nodules were well on their way to becoming definite periurethral abscesses; others were merely extensive areas of periurethral sclerosis often containing small areas of anæmic necrosis.

Occasionally acute retention may be the initial symptom as in eighty of our cases. Pathologically an acute congestion at the site of stricture, it is most often precipitated by exposure to wet, cold or by excesses—gastric, alcoholic, or sexual. In twenty-nine the urinary obstruction amounted to chronic retention with overflow dribbling. The subsequent course in these cases is identical with that of chronic prostatic obstructions. If unrelieved, early death ensues.

In this series we have no data bearing on the relationship of stricture to sexual performance. It is well known, however, that in the presence of advanced stricture (and sometimes even moderate), sclerotic involvement of the periurethral corpora may render the patient impotent, chiefly by sufficient obliteration of the corporeal meshes. Other symptoms of sexual dysfunction are secondary to accompanying prostatitis, seminal vesiculitis and verumontanitis.

STRICTURE OF THE MALE URETHRA

Physical Examination.—Not infrequently in the course of the examination for another condition of the urinary tract, urethral stricture will be disclosed as the underlying cause. On the other hand, in examining patients for stricture, we often disclose associated disease. (Table VII.) Epididymitis

TABLE VII.
Physical Examination.

	Absent	Abscess	Indurated	Enlarged	Tender	Boggy	Undescended
Scrotum.....		115					
Testicle.....	9	4		12			4
Epidid.....	1		98	10	14		
Prostate.....	3	5	157	309	71	79	
Sem. ves.....			107		9		
Perineum.....		182	173				

usually due to the pyogenic cocci or the colon bacillus frequently accompanies stricture. It may at times be the initial symptom and because of the characteristics of its particular bacterial etiology these lesions often terminate in suppuration. Fourteen of our patients had acute epididymitis, bilateral in two. Subacute epididymitis was noted twice, tuberculous epididymitis once, scrotal abscess eight times in cases without extravasation, hydrocele nine times (once ruptured).

Often an acute orchitis will accompany epididymitis or may appear as an apparently distinct lesion. Orchitis is most often caused by the same organisms causing the epididymitis and is, therefore, characteristically a suppurative process necessitating orchidectomy as in five of our cases. The testicle was noted to be enlarged and tender in twelve, atrophic in several, surgically absent in nine, and undescended in four.

Prostatitis and seminal vesiculitis are an integral part of the stricture picture. We found the prostate absent (surgically removed) in three, boggy in seventy-seven, adenomatous in six, indurated in 157, carcinomatous twice, tuberculous once, abscessed in five, and enlarged by inflammation in 309. Seminal vesiculitis, acute and chronic, was noted 116 times with abscess once, although inflammatory changes in both the prostate and vesicles are of far greater incidence than these figures would indicate. It should be added that this one vesicle abscess subsequently ruptured into the peritoneal cavity with fatal outcome.

Periurethral abscess is perhaps the most common surgical complication of stricture and was observed 188 times (15 per cent.). It represents the suppuration of nodular periurethral infiltration. The onset may be so rapid that the various phases of adenitis, periadenitis and infiltration are unrecognized by the patient. These abscesses were found most often along the perineal urethra but are not uncommon to the scrotal and penile urethra.

Extravasation of urine is but a step further in the picture of periurethral phlegmon. (Fig. 2.) Of 132 cases of urinary extravasation observed, in 112 stricture was determined to be the primary surgical lesion. Twenty of these

had been previously operated upon for stricture but had neglected subsequent instrumentation. The pathology of urinary extravasation we have described elsewhere.⁵ Suffice it to say, urethral obstruction is not a pre-requisite and the urinary and phlegmonous diffusion is not always due to urethral rupture by force of obstructed urination. Most often the primary lesion is an adenitis,



FIG. 2.—Urinary extravasation secondary to urethral stricture. Penile and scrotal swelling and gangrene with marked suprapubic infiltration are noteworthy.

peradenitis and periurethral infiltration with suppuration. Infiltration by such urine as may escape into the tissues is through the ulcerated urethra at the point of the localized acute inflammatory process.

Many other conditions may be associated with stricture. Fistulæ are common. We found 102 in the perineum, fourteen in the anterior urethra, and eight were urethro-rectal. The orifices of fistulæ may be some distance from the urethra. They have been seen in the flank. The "watering pot" perineum is frequently observed.

One case presented a bullet in the urethra. Although the patient alleged he had been shot there many years before, the foreign body had unquestionably

been otherwise and more recently introduced. Urethral calculi were found in eleven cases. Some of these were individual round stones, too large to pass the obstruction; in others several stones faceted together gave the picture so frequently presented by biliary calculi. One benign and one malignant papilloma (so diagnosed histologically) were discovered.

Back pressure with its attendant dilatation and infection produces a true cystitis in most cases of stricture. Usually it is considered part of the clinical picture but rarely may become intensified to the stage of ulceration as noted twice. Diverticulæ were found twice; bladder calculi were removed five times. In three cases vigorous pre-operative urethral bleeding into the bladder so filled this viscus with clots that cystotomy was necessary.

STRICTURE OF THE MALE URETHRA

Kidney damage is present in every case proportional to the duration and degree of the obstruction. Surgical kidney infections were encountered in thirteen patients, and renal calculus in one. The phenolsulphonephthalein tests recorded herewith (Table VIII) are not in each instance a true index of the actual renal damage as it would be observed histologically.

TABLE VIII.
Functional Examinations.

Urine:		Phenolsulphonephthalein test	
Plus 789		(per cent. in 2 hours intramuscularly):	
Blood 231		None.....	3
		Trace.....	4
Blood pressure (systolic):		Under 5%.....	15
Under 100 mm. Hg.....	22	6-15%.....	88
100-140 mm.....	118	16-30%.....	88
141-180 mm.....	25	31-50%.....	131
Over 180 mm.....	2	Over 50%.....	101
Non-protein nitrogen:		Creatinin:	
Under 35 mgms. 100 c.c.	317	Under 1 mgm. 100 c.c.	6
36 to 50 mgms.....	122	1-2 mgms.....	201
51 to 75 mgms.....	36	2-3 mgms.....	69
76 to 150 mgms.....	11	3-4 mgms.....	12
Over 150 mgms.....	7	Over 4 mgms.....	9

Whether because of advancing years or of severe nephropathy with nitrogenous retention, cardio-vascular disease is a frequent clinical complication. A failing heart (myocarditis) prevents many post-operative recoveries.

On admission three patients were suffering from delirium tremens, four others were irrational and twenty-six were in terminal urosepsis. Twenty-one presented pulmonary complications in addition to stricture—tuberculosis, pneumonia, bronchitis, pleurisy, and pulmonary oedema. Seven were admitted with arthritis, of gonorrhœal origin in three, suppurative in three others, and tuberculous once. These various complications have been enumerated at length because when these associated lesions are severe, they may be the direct cause of an early death.

Laboratory findings and functional tests are, in a sense, a phase of the physical examination. (Table VIII.) Albuminuria usually means a toxic nephritis and often disappears with the establishment of proper urinary drainage. Blood cells may afford a false index to the quantitative estimation of renal albuminuria. Careful examination will always reveal a few pus cells. These may be present as (1) a microscopic finding or (2) in sufficient quantity to cloud the urine or (3) may constitute a goodly portion of the urine specimen. We have seen urine from these cases, the purulent sediment of which was over a third by volume.

Blood was noted as present, grossly or microscopically, in one of every six patients but we believe the actual incidence to be much higher.

Although long standing urinary retention is commonly supposed to cause increased blood pressure, in but two of 147 cases with recorded blood pressure was the systolic pressure over 180 mm. mercury. Once it was 235 mm.

and once 202 mm. In two-thirds of the recorded readings it ranged between 100 and 140 mm. and in twenty-one cases was less than 100 mm.

Blood chemistry and the phenolsulphonephthalein excretion estimation have constituted our renal function tests. The former tells what the kidneys have been doing in the immediate past; the latter what they are doing at the time of examination. The non-protein-nitrogen and creatinin findings were normal in two-thirds of the cases in which it was used. (Table VIII.) In seven, however, the non-protein-nitrogen was over 150 mgms. per 100 c.c. of blood, the highest being 300 mgms. In six cases the creatinin was over five mgms. per 100 c.c.; 7.2 mgms. was the highest. Two of these with five mgms. of creatinin per 100 c.c. survived. A creatinin estimation of three mgms. or over warrants an unfavorable prognosis although, as just seen, some of these patients will recover.

In later years the phenolsulphonephthalein test has been employed routinely. It is injected intramuscularly and the output for two hours estimated. In one-fourth of these it was found normal. Three showed none in two hours, four others but a faint trace. The total output was less than 50 per cent. in three-fourths of our recorded estimations. (Table VIII.)

Urethral smear revealed the gonococcus fifty-five times, the staphylococcus eighteen times, streptococcus twenty-two times and *B. coli* five times. Although a history of chancre was given by 248 patients, the Wassermann test was positive in but ninety-two. This observation is of minor importance, however, as we observed no cases in which there was the question of intra-urethral chancre as the cause of stricture.

Diagnosis.—The passage of an instrument through, and the grasping of it by the scar constitutes the diagnosis of stricture. The bulbous or olivary bougie is the instrument of our choice. One first passes a large bulb, a 28 F., for example. If this can be passed one notes any obstructions to its introduction or to its free withdrawal. In the presence of stricture, as the instrument is withdrawn through the urethral scars, a jump or series of jumps will be felt. These are strictures of large calibre and one does well to observe them endoscopically also. If the 28 F. bulb will not pass, progressively smaller instruments are used until one is found which will pass the obstruction and will elicit the characteristic "hang" of stricture. Not infrequently no instrument can be passed, not even a whalebone filiform. On the other hand, many apparently small calibre strictures deceive in that difficulty of penetration of their lumina is due to tortuosity rather than tightness. In such cases a larger instrument will not infrequently go where the smaller is caught in irregular folds and abrasions. Lacerations of the urethra from recent instrumental trauma may also afford an apparently impassable channel. Certain strictures are found to be impassable.

Protracted sessions of instrumentation are ill advised in cases of acute retention, and once urethral obstruction (other than prostatic) is determined by a large instrument, filiforms may be profitably and wisely employed at once.

STRICTURE OF THE MALE URETHRA

We have found the Phillips whip with a small follower catheter of great value since it combines filiform, dilatation and drainage.

Other diagnostic aids are the urethroscope and the steel sound. The urethroscopic picture of stricture, an intensely inflamed mucosa or, in the absence of acute congestion or recent instrumentation, a pallid membrane with numerous erosions, granulations, follicular infections against the rigid and rather straight sclerosed urethral wall, will indicate the lesion but gives no accurate data regarding its calibre unless the scar will permit the passage of the endoscopic tube. Occasionally by means of the urethroscope one may pass filiforms through an otherwise impassable stricture.

Diagnostic reliance on the grasping of the steel sound by stricture is advocated particularly by Keyes, and while bougies have little or no diagnostic value if the stricture is of filiform or fine calibre, sounds may have no value in diagnosing strictures of large calibre, not uncommonly observed lesions which may give rise to urethral symptoms—most often a chronic discharge.

Since the tendency to contract is the inherent characteristic of scar tissue, if the stricture is untreated, the clinical course is one of increasing severity. As there is no uniform rate of contraction, we find some strictures developing within a period of weeks; others are not clinically manifest within twenty years. The course is one of obstruction and infection, intermittent or continuous gleet, exacerbations of urethritis, an occasional periurethral abscess and, if the patient lives long enough, ultimate retention. A series of acute retentions may go unheeded until the final picture is that of complete chronic retention with overflow and continuous dribbling. The contraction rate of the scar on the one hand and the nature and extent of treatment on the other determine the course of the disease. Temporarily relieved, most patients neglect themselves; the lives of many are checkered with urethrotomies. One-fourth of our patients had had urethrotomy performed previous to the present admission and most of the others had followed an irregular course of sounds.

Treatment.—As recognized over three centuries ago by John Read,⁴ the prophylactic or preventive treatment of stricture means proper management of the acute urethritis. Under-treatment is preferable to over-treatment. The urethral mucosa merits the same delicacy of therapeutic consideration as does the conjunctival mucosa.

Resorption of the inflammatory exudate common to chronic urethritis is best achieved by the passage of steel sounds. Many operators also employ the Kollman dilator. Dilatation acts as gentle massage and, by promoting congestion, stimulates the absorption of inflammatory exudate.

The non-operative treatment of stricture is dilatation, persistent and prolonged. It will cure a few and control all. A certain amount of inflammatory infiltration will be absorbed; formed scar will remain unless excised.

Gentleness and antisepsis are co-requisites. Of the two, gentleness is the more important. Asepsis of instruments and the hands is assumed. Instrumental trauma will aggravate and prolong a sub-acute infection. Gentle urethral instrumentation not infrequently stirs up a latent infection. This is best

combated by the introduction of antiseptics—1/5 per cent. silver nitrate or 1-1000 acriflavine after treatment. We have found, however, that if the patient cleanses the urethra by urination before instrumentation and again voids after, the danger of infection is minimized.

Local anaesthesia intraurethrally is advisable while the mucosa is still tender or until one determines the contour of this passage.

For further discussion of urethral instrumentation reference in the standard text is suggested. Of extreme interest is the first description of this technic. (Read.³) It is complete to the degree of dictating the use of filiforms,

the relative position of patient and surgeon, and indicates clearly the phenomenon of urethral chill.

We found that of the 1244 cases admitted a third required no operation. They were dilated sufficiently (some under anaesthesia) and discharged to the out-patient department for continuation of treatment. Some of these showed no response to periodic dilatation and were referred back for operation. This failure to respond to dilatation is an indication for operation. It should be added, however,



FIG. 3.—Post-operative appearance of lesion like Figure 2. The stricture has been cut, perineal drainage tube inserted to bladder and anchored, genital and suprapubic gangrenous tissues incised widely for drainage. Testicles swinging freely. Recovery.

that a number of strictures were cut which might ultimately have yielded to gradual dilatation. For economic reasons and because so many of these patients are neglectful and careless of their best welfare, this immediate dilatation to maximum calibre by operation seemed advisable in many cases which otherwise would not have been operated upon.

In a measure, the site of stricture offers certain suggestions as to how it can best be treated. Stricture of the meatus should be cut. While well formed stricture of the pendulous urethra more frequently requires cutting as well as repeated dilatation, those of the bulb, unless complicated by active periurethritis, will usually respond to dilatation alone. Strictures of the deep urethra (membranous) are usually traumatic in origin, contract rapidly and require cutting. Periurethral abscess and impassable stricture each demand incision.

Internal urethrotomy on the roof of the canal is the indicated procedure if the stricture is in the anterior urethra, if it permits the passage of a filiform, and if there be no periurethral infection. External urethrotomy is performed chiefly in cases complicated by periurethral infection, for impassable stricture

STRICTURE OF THE MALE URETHRA

or those which admit a filiform but not the urethrotome and for strictures of the deep urethra. In this series 848 patients were operated upon. Some were operated upon more than once while others had more than one type of operation performed at the same time. Internal urethrotomy was performed 143 times, external 433 times, combined external and internal urethrotomy 310 times. Other operations employed were incision and drainage of associated periurethral abscess 152, excision of urethral fistula ninety-five, suprapubic cystotomy twenty-seven, urethral resection five, and sounds passed under anæsthesia eight times. Forty-eight patients in whom operation was indicated refused this treatment.

Anæsthesia.—We have found that all forms of urethrotomy may be performed on the conscious patient. Seventy-one internal urethrotomies were done using novocain locally in the canal. Oddly, five of these subsequently died. Spinal anæsthesia is the anæsthesia of our preference for perineal section but it is only since 1920 that we have used this form of regional block with complete satisfaction. Prior to this all patients were given general anæsthesia. Recently⁶ in comparing post-operative pulmonary complications in a group operated upon under ether and a group operated upon under spinal anæsthesia, we found the pneumonia ratio to be seven to one. Post-operative convalescence is less stormy with spinal anæsthesia and disturbing post-operative sequelæ fewer. For the past year we have been giving 50 mgms. of ephedrin sulphate intramuscularly fifteen minutes before the spinal injection. This has abolished alarming falls of blood pressure in all cases. If the initial injection of ephedrin does not sufficiently stabilize and support the blood pressure, it may be repeatedly employed without ill effect but we have never had reason to administer more than two injections. Caudal block was used eleven times. Three cases, moribund, had perineal section performed without anæsthesia. The types of anæsthesia administered and number of each with the group mortality are shown in Table IX.

TABLE IX.
Anæsthesia 848 Cases.

Type	Number given	Deaths after		Total deaths
		Without extrav.	With extrav.	
General.....	474	19	23	42
Spinal.....	727	15	17	32
Caudal.....	11	0		0
Local.....	79	5	4	9
None.....	4	3		3
Died without operation.		11	2	13

Internal Urethrotomy.—If the stricture is of filiform calibre the Maisonneuve instrument threaded to its whip filiform guide is passed. If the scar will permit passage of the Otis urethrotome this instrument is used. After

first cutting a filiform stricture with the Maisonneuve we introduce the Otis instrument and cut on the urethral roof to 35 F. so that a 30-32 F. sound may be passed to the bladder. An indwelling catheter attends to possible hæmorrhage and affords bladder drainage. As a rule, this is withdrawn the following day.

External Urethrotomy.—With the patient in lithotomy position under spinal anæsthesia, and with a small sound or filiform in the urethra as a guide the stricture is cut on the floor (at which time the vesicle neck may be palpated for irregularity or contraction), and a perineal bladder drainage tube anchored in place. In 158 of these patients, only a filiform could be passed to the bladder pre-operatively.

If the stricture has been found impassable, as in 157 cases, three avenues of approach are open. After injection of the canal with a half ounce of methylene blue for identification of the lumen, the perineal urethra may be (1) exteriorized by dissection and opened, (2) may be approached retrograde through the bladder by cystotomy as we did three times or (3) retrograde through the membranous urethra by perineal prostatic exposure following forward from the prostatic apex, as in two of our cases. With care and an accurate knowledge of perineal anatomy, one can usually contrive to enter the urethra by the first route. Once entered the stricture is cut and the bladder drained. Complicating anterior strictures are also cut. Often troublesome false passages in the pendulous urethra may be circumvented by passing the urethrotome retrograde from the perineal urethral opening. After performing a urethrotomy one should be able to pass a 30 F. sound without obstruction from meatus to bladder.

Associated periurethral abscesses are freely incised and afforded ample drainage. Rubber drains best keep these open although a gauze pack may be required to check obstinate oozing of the indurated tissues.

Complicating extravasation of urine demands inordinately wide incisions. We bisect the scrotum if necessary, perform extensive débridement of gangrenous tissues and incise widely to the boundary of healthy skin. If this is not done the gangrenous process continues, more tissue is involved, and a secondary operation required. Only half of those making a second trip to the operating room for extension of drainage incisions survive.

Post-operative care entails flooding the patient with water by mouth, rectum or hypodermoclysis. Fluid is life saving. We have given as many as four hypodermoclyses of over 1000 c.c. each in 24 hours. If the heart does not weaken there is little danger of waterlogging the patient. Digitalis is freely used under medical supervision.

As a rule the perineal tube is removed on the third day although badly infected bladders, poorly functioning kidneys or otherwise grave prognostic signs are indications for prolongation of this drainage. It will be found that many will become febrile with chills and other indications of sepsis on removal of the tube. If continued, this picture indicates replacement of the drainage. In two cases vigorous hæmorrhage followed removal of the perineal tube;

STRICTURE OF THE MALE URETHRA

both required suprapubic cystotomy for evacuation of clots distending the bladder. Moreover, it is noteworthy that with this evacuation all bleeding ceases.

The passage of sounds is begun routinely on the seventh to tenth day post-operative and is continued every five days thereafter. Occasionally severe urethral chill with urosepsis will be observed; in such cases greater care must be exercised in future instrumentations. However, if benefit is to be derived from urethrotomy, it is imperative that dilatation begin after cutting of the stricture so that union of the incised band of scar may not occur and that such new post-operative scar as may be formed will be minimal.

Post-operative Complications.—Urosepsis is the most severe of post-operative complications and in our series was of greatest incidence. Clinical distinction between uræmia as a phase of renal dysfunction and generalized septicæmia of bacterial origin is sometimes quite impossible. As a rule the blood chemistry in the former will indicate marked nitrogenous retention and the culture of the blood in the latter often reveals a bacteriæmia. Free bladder drainage and high fluid intake offer the only hope of recovery in such an event.

Vigorous urethral hæmorrhage occurred ten times and required suprapubic evacuation of clots in five cases, in three of which only internal urethrotomy had been done. Firm application of a perineal packing under a tight binder will check some of these hæmorrhages if the posterior bulbous urethra is bleeding. The insertion of an indwelling catheter will stop hæmorrhage from the anterior urethra.

Pneumonia may result from inhalation anæsthesia or in the elderly may be of hypostatic causation. It is probably more often an embolic process. One patient with no pulmonary history and with negative chest findings pre-operatively was seized with a sudden voluminous hæmoptysis three days after operation. This subsided temporarily but recurred. The patient died. Although no autopsy was granted, we were unquestionably dealing with pulmonary embolism. Pneumonia was the immediate cause of death in eight patients. Myocarditis with clinical cardiac failure killed six. Intestinal paresis with enormous abdominal distention was fatal once.

Acute epididymitis followed operation in seven patients, abscess of the testicle occurred five times, periurethral abscess eight times, prostatic abscess three times and acute pyelonephritis was recorded seven times.

Many of these complications required additional operations. It is not uncommon to find that a urethra cut at operation to permit free passage of a 30-32 F. sound to the bladder will, when instrumented ten days later, be found exceedingly tight or even impassable. Because of this phenomenon, internal urethrotomy was repeated ten times, external twelve times. In six other cases the administration of an anæsthetic produced relaxation so that a previously tight or impassable channel was easily entered and dilated.

Incision and drainage of newly developed periurethral abscesses was necessitated twelve times. This usually means that the primary incisions were too meagre or that free drainage was otherwise blocked. Thirteen of 112 cases

of urinary extravasation secondary to stricture required extension of the drainage incisions, and in four of these extension of the phlegmonous process over the abdominal wall had occurred.

Cystotomy was performed for hemorrhage five times, for drainage incident to repair of perineal fistulae eight times, and for prevesical abscess and the removal of a foreign body, each once. The foreign body removed was the broken-off head of a Pezzer catheter which had become heavily impregnated with lime salts, virtually forming a calculus. Vesical calculi were

removed suprapubically in five cases.

The punch operation relieved associated prostatic obstruction once. Newly developed prostatic abscesses were drained three times.

Epididymotomy and epididymectomy were each performed once and orchidectomy five times. Very probably the suppurative process in some of these testicles was secondary to an unrecognized or neglected suppurative epididymitis.

Urethral fistulae were repaired eleven times; urethro-rectal fistulae once. In two cases of extensive urinary extravasation due to stricture, a penile plastic repair with skin graft was performed. (Fig. 4.)

The recital of the relative frequency of the



FIG. 4.—Use of Thiersch grafts to accelerate genital cutaneous repair. Satisfactory end result.

complications in such a large series of cases affords more actual information regarding post-operative possibilities in stricture surgery than a descriptive essay. Experience has taught that irrespective of an excellent prognosis, post-operative convalescence is fraught with numerous undesirable potentialities. One patient, well recovered from the operation and nearly ready for discharge from the hospital, developed urethral chill and metastatic cerebrospinal meningitis following the passage of sounds. He died. The prognosis in all cases therefore must be guarded.

STRICTURE OF THE MALE URETHRA

Ten hundred and ninety-three of these patients were discharged as improved, nine were unimproved, thirty-six left at their own risk and ninety-nine died. Forty-four of these deaths occurred in a group of 112 cases complicated by urinary extravasation. Of the ninety-nine fatalities, thirteen were in unoperated patients. These were either admitted in coma and died before operation could be performed, or sick on admission; they refused surgical treatment.

Though discharged as improved, the urethræ of 276 patients would admit a sound no larger than a 25 F. In two of these, with impassable stricture pre-operatively, a filiform only could be passed at time of discharge. Often severe renal infection and "urethral fever" following instrumentation defers one from the systematic periodic passage of sounds. During the protracted interval great contraction of the old stricture with formation of new scar ensues. The urethra of a patient of mine will regularly contract in a period of three weeks from 20 F. to filiform calibre. Many such urethræ will be benefited if not actually cured by resection of the scar, and end-to-end anastomosis. In one of five cases so operated upon in this series, 5 cm. of urethra was removed with good result.

Perineal leakage may persist for some weeks following external urethrotomy but in most instances represents but a phase of persistent obstruction. With full dilatation of the canal these fistulæ will rapidly heal if the tract is curetted occasionally and granulations destroyed.

Urinary incontinence following external urethrotomy means probable injury to the external sphincter. Partial incontinence followed external urethrotomy in four cases.

Prognosis.—In a large group of cases such as this, subsequent histories offer a broad prognostic index. Ninety-nine or 7.3 per cent. of all cases died. The operative mortality exclusive of extravasation cases was 4.9 per cent., inclusive of these 10.1 per cent. It is noteworthy that of stricture cases complicated by extravasation over half terminated in death (54.2 per cent.). (Table X.)

TABLE X.

Mortality.

Total mortality—all cases.....	7.3%
Total mortality—operative cases including those with extravasation.....	10.1%
Without extravasation.....	4.9%
Mortality extravasation—stricture cases.....	54.2%

Clinical follow-up is so unsatisfactory among charity hospital patients, especially in a large city, that consideration of the pre-operative history best indicates what we may expect subsequent to our operative treatment.

A few will probably be cured. The majority will pursue an irregular course of sounds, during the increasing lapses of which sclerosis will intensify. The vicious cycle of contracting scar with increasingly painful instrumentation prompting longer intervals between dilatation, and again more scar, will ensue. While this is going on, intercurrent flareups of urethritis, prostatitis

or periurethral abscess will serve but to aggravate the fundamental lesion. These patients may weather several acute retentions, many will become incontinent by overflow from a chronically distended bladder, a few will develop urinary extravasation and within the period of a few years over a third of the entire number will require reoperation. Of this relapsing group, a fourth will require reoperation within two years, and two-thirds within ten years. Of our patients twenty had been operated on twice previously for stricture, seven three times, two four times, one seven and another nine times. (Table IV.)

SUMMARY

1. Urethral stricture in the male is of prime importance among surgical lesions of the urinary tract.
2. A detailed study of twelve hundred and forty-four cases of stricture is reported.
3. Over 90 per cent. of urethral strictures are of inflammatory origin; nearly all follow gonococcus urethritis. Though gonorrhoea be denied by the patient, the gonococcus will be sometimes revealed by careful examination.
4. Since columnar and cylindrical epithelium favor gonococcus growth and squamous epithelium is resistant to this infection, inflammatory stricture is common to the anterior and bulbous urethra but rarely found in the membranous portion. The latter, however, is the site of most traumatic strictures, the straddle injuries of the perineum.
5. Improper treatment of the antecedent urethritis accounts for most gonorrhoeal stricture even though the lesion may give no symptoms until twenty years later.
6. Stricture depends on the severity of the urethritis rather than on the duration.
7. The majority of inflammatory strictures are clinically multiple though pathologically they may be single. Traumatic strictures are usually single.
8. Nephropathy secondary to stricture obstruction is of prime concern. We consider and treat stricture on the basis of renal damage and infection.
9. Prognosis rests on renal function and broadly speaking is proportional.
10. The symptoms of stricture are varied and may be present many years before acute local inflammation precipitates search of medical relief. Alteration in the size of the urinary stream, terminal dribbling, dysuria, frequency of urination, hæmaturia, and an intermittent gleet are perhaps most commonly observed. Acute retention may be the first symptom noted.
11. Associated complicating inflammatory lesions are frequently observed.
12. Diagnosis of stricture rests upon grasping of an urethral instrument by the scar. The most accurate diagnosis is afforded by eliciting the "hang" as an olivary bougie is withheld by the scar; a jump is felt as the bulb is pulled through the stricture.
13. Urine shreds are always present with stricture; urinalysis frequently discloses blood.

STRICTURE OF THE MALE URETHRA

14. Estimation of the non-protein nitrogen and creatinin content of the blood and the two-hour phenolsulphonephthalein test (intramuscular route) have been the function tests employed.

15. The preventive treatment of stricture lies in proper treatment of urethritis.

16. Dilatation constitutes the non-operative or palliative treatment. Its employment must be persistent and prolonged.

17. Failure to respond to dilatation and certain complicating infections are the indications for operation.

18. By internal urethrotomy strictures of the pendulous urethra and scrotal bulb are cut. An indwelling catheter provides bladder drainage and checks bleeding.

19. For deeper strictures perineal section must usually be performed. When this is done, a perineal bladder tube should always be used.

20. Extensive multiple strictures may require both external and internal urethrotomy.

21. Spinal anæsthesia is the anæsthetic of our choice for urethrotomy.

22. Preservation of free urinary drainage, free evacuation of the bowels, and forced fluid intake sums up the immediate post-operative care.

23. Dilatation with sounds beginning seven to ten days after urethrotomy and continuing every five to ten days thereafter until the canal maintains a normal calibre, should be performed with rare exception.

24. Numerous post-operative complications may develop, many of which are potentially fatal. The most important of these are urosepsis, hæmorrhage and pneumonia. Localized suppurative processes require incision and drainage.

25. While the immediate mortality (excluding cases of urinary extravasation with a 45 per cent. mortality) is about 5 per cent., most patients are improved by operation; but one-third will require reoperation, two-thirds of these within ten years.

26. Foremost in the consideration of all urethral instrumentation is gentleness. Actually it is of greater importance than asepsis.

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URETHRAL STONES

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THE lodgement or development of concretions in the urethra is of unusual but by no means rare occurrence. It has been of importance in seven of the 2,900 urological cases in my practice. Ordinarily the canal is large enough to permit the passage of any object that is small enough to gain entrance to it at the vesical orifice, and the development of stones here is quite unusual. This is particularly true of the female, in whom the urethra is short, straight and of a comparatively large calibre, whereas in the male the natural curves and normal narrowings as well as strictures that may be present rather favor the arrest of any body passing through it.

Ordinarily the lodgement of a stone is preceded or followed by symptoms that draw the attention of the patient to the condition and make him seek relief at once. This is not always true, however, for instances of stones having remained in the urethra for twenty years have been recorded, and the removal of specimens that show polished facets, in positions that could only be the result of long-continued coaptation in the location in which they were found, proves that they must have been there for long periods.

They are spoken of as *primary* when they have their origin in the urethra and as *secondary* when they are arrested there after having been formed and set loose elsewhere. Evidence that is unquestionable of the primary nature of any given stone is very difficult to secure unless it happens to have been formed about a foreign body. The fact that a stone is found in a urethral diverticulum or behind a stricture does not speak conclusively for its being primary. An irregularly laminated structure indicates that the stone may have increased in size by successive deposits of salts which are usually thickest in a direction closest to the bladder.

Their color, consistency, and shape vary with their chemical composition, the parts with which they have been in contact and the length of time they have been in the canal. The size is also variable, some as large as nine centimetres in diameter and weighing as much as 390 grams having been reported.

They may be found in any part of the urethra but are most common in the prostatic position. Englisch gives the following percentages in 361 reported cases collected: Fossa navicularis, 11; penile portion, 15; scrotal, 14; bulb, 19; prostatic, 41.

They are usually single but may be multiple, as many as 230 having been reported by Civiale in the posterior urethra.

The symptoms are quite variable and variegated. Perhaps the most common is a sudden stoppage of urination during the act, followed by retention or by dribbling which may or may not be relieved spontaneously. If this has

URETHRAL STONES

been preceded by an attack of renal colic and if a small kidney or ureteral stone is known or suspected to be present, the diagnosis is generally simple. Without such a history, however, the symptoms may be confusing. Once a stone has lodged in the urethra, more or less inflammation is set up which will be stubborn unless the cause is recognized and relieved. In some instances the patient comes under observation with extravasation of urine, the stone having caused ulceration and gangrene of the urethra and the stone noted as an incident in operations for the relief of that condition. Some patients bear their difficulty for long times without seeking relief, using various means such as moving the stones about by pressing on the perineum, drawing downward on the scrotum and testicles, etc., to make urination possible.

In a frank case with history of renal colic or of stone followed by sudden stoppage of the stream of urine, the diagnosis is generally easy. A nodule may be palpated along the urethra at the site of lodgement and an obstruction to the passage of an instrument noted at this point. Crepitus may be noted if the stones are multiple. The typical click may be secured if the instrument used is of metal. The diagnosis may also be made by finding scratches on a bougie coated with wax. The X-ray will also be of service.

The treatment must be varied to suit the case and will depend upon the location and size of the calculus as well as upon complications that may be present. The simplest procedure that will effectively remove the calculus should be used, and the ingenuity of the surgeon will be sometimes taxed to devise a method that will do away with the necessity for a cutting operation. In general, the object is to pull out, push back or break up the calculus.

In the fossa navicularis a simple meatotomy will generally enable one to push the calculus out by external pressure or to remove it in the grasp of forceps.

In the penile urethra the passage of several filiforms about the stone and simultaneous withdrawal of them may effect removal or the stone may be grasped with a forceps through a urethroscope. The stone may be withdrawn in the grasp of one or other of the various instruments devised for the purpose of dislodging ureteral stones. If a stricture is present, its division by internal urethrotomy should precede other manipulations. Various forceps devised for grasping stones may be used with more or less success. In general it is best to avoid crushing the stones on account of the danger of leaving fragments behind and because of the possibility of seriously wounding the urethra. With stones of any considerable size in the bulb minor measures are apt to fail and make an external urethrotomy necessary.

Other things being equal, the prospects of success with minor measures are lessened the deeper the stone is in the urethra. If extravasation is present a perineal section should, of course, be done at once.

If the stone is large enough to obstruct and is in the prostatic urethra, the passage of a sound may force it back into the bladder, after which it may be treated as a bladder stone. Multiple stones in the prostatic urethra are

generally complications of a lesion of the posterior urethra and their removal only incidental to the treatment of that condition.

CASE I.—No. 215, F. W. M., age legal, housewife. During previous ten years had had five abdominal operations for relief of vague abdominal pains; had never been X-rayed or cystoscoped. Sudden obstruction to urination during the act followed by complete retention. Patient refused to be catheterized and retention was gradually



FIG. 1.—Calculi impacted in urethra. (Case VI of text.)

relieved. One month later she developed tumefaction at the side of the urethra and consulted a physician who referred her to me.

Examination showed a small mass just back of the urinary meatus. There was a marked non-specific urethritis and two openings of an abscess at either side of the urethra. The bladder urine obtained on passing a No. 18 F. catheter was clear. On trying to pass an endoscope a click was noted, but she was so tender that she refused further manipulation.

URETHRAL STONES

The diagnosis of impacted stone in the urethra was made and confirmed by a letter from her a month later. A "large stone" had been removed by Doctor Lewis, of Cleveland, with complete relief of symptoms.

CASE II.—No. 1149, M. W. M., age seventy years, sailor. Rough calculus 3.0 millimetres in diameter encountered just back of meatus on attempting to catheterize for relief of obstruction due to prostatic adenoma. Stone removed with artery forceps and prostatectomy accomplished without complication.

CASE III.—No. 1929, M. W. S., age twenty-nine years. Patient with left ureteral stone. Felt stone pass into bladder and later along urethra during urination and stop at meatus, after which very little urine could be passed. Rough, irregular calculus $10 \times 5 \times 3$ millimetres removed by meatotomy.

CASE IV.—No. 2565, M. W. S., age fifteen years. History of "nephritis" for four years. Clears up at times but when quite normal has nocturia of two. Has passed stones at intervals and recently one stuck in urethra but was passed later.

Present attack came on four hours before as stoppage during urination followed by complete retention. Small nodule palpated at midpoint of penile urethra at point at which obstruction to catheter occurs. After various manipulations, three stones were removed in the grasp of a spiral ureteral stone dislodger. Patient died of uræmia eighteen days later and necropsy revealed bladder and bilateral renal tuberculosis.

CASE V.—No. 2107, M. W. S., age twenty-seven years. Bilharziasis at fifteen years. Difficulty of urination four months ago. For past twenty-four hours has had pain in hypogastrium. Painful frequent urination and terminal hæmaturia.

Catheter arrested at bulb and pressure causes great pain. Waxed-tipped filiform shows scratch marks. X-ray shows stone 1.0 centimetre in diameter in bulb.

Stone pushed into bladder on passing sound preparatory to external urethrotomy and was later removed by crushing with a Young rongeur. Convalescence uneventful.

CASE VI.—No. 2614, M. W. M., age sixty-five years. Incontinence of urine and hæmaturia for six months past. Nocturia two to three for two months.

Palpable masses that crepitate extend from midpoint of penile urethra to bulb. X-ray shows a series of five to six urethral stones, a large stone in the left ureter and a small one in the left kidney region. Six urethral stones depicted removed by external urethrotomy through two urethral incisions from single perineal wound. Later removal of prostatic adenomata.

CASE VII.—No. 2780, M. W. M., age forty-six years. Previous gonorrhœa. Recent retention of urine relieved by catheter which was left indwelling. Crepitus noted in prostate on rectal examination. X-ray shows prostatic stones. Round stone 4.0 millimetres in diameter in eye of Malecot catheter removed preliminary to cystoscopy. Prostate inflamed and contains stones but is not adenomatous.

EXTRAARTICULAR ARTHRODESIS OF THE HIP FOR TUBERCULOSIS *

WITH A REPORT OF 31 CASES

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BRISTOW, in a recent article on Arthrodesis in the *British Journal of Surgery* refers to extraarticular arthrodesis of the hip as "a recent innovation". This statement is somewhat surprising, as the author did an extraarticular arthrodesis of the hip in 1913, and reported a series of cases, describing the technic in detail, in 1919. Julius Hass reported his technic in 1922. The Hibbs' procedure, which is very similar to that of Hass, was presented by Farrell in 1925 and Hibbs in 1926. Neither the Hass nor Hibbs technic is completely extraarticular.

Tuberculosis of the hip is a condition most unfavorable to intraarticular arthrodesis, either spontaneous or operative. The reasons for this are obvious: (1) Inhibition of osteogenesis by the tubercle bacillus; (2) the peculiar anatomy of the joint frequently causing recession of bone surfaces from each other as bone destruction progresses, or following intraarticular removal of bone by the surgeon for arthrodesis purposes, because of the ball and socket contour of the hip-joint (peripheral destruction of the femoral head causes it to become smaller, whereas peripheral destruction of the acetabulum causes it to become larger). Also, because of the anatomy and mechanical relationships of the hip and pelvis, as extensive destruction of bone progresses the diseased bony surfaces of the femur and pelvis do not tend to approximate because of impingement of the inside of the trochanter against soft parts at and above the rim of the acetabulum. Since the tubercle bacilli inhibit the active osteogenesis which would normally take place, dead spaces filled with caseous material are left between the bony elements, and spontaneous ankylosis and cure become improbable. Even if intraarticular arthrodesis is attempted, the impossibility of removing all tuberculous material, and the possibility of causing metastatic infection or sinuses with secondary infection, the low osteogenetic potentiality of the bony elements of the joint, and the consequent failure to secure fusion render the operation untrustworthy.

Bracing in cases of extensive destruction and caseation, largely for the same reasons, has been signally unsuccessful.

Extraarticular arthrodesis, first used by the author in 1913, and described in 1919,¹ is a most satisfactory alternative. By strongly bridging the joint with a tibial, femoral or iliac graft or grafts mortised into the bony elements on both sides of the joint, complete fixation is secured. The immobilizing

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ARTHRODESIS OF HIP FOR TUBERCULOSIS

influence of union of the femur to the pelvis makes it unnecessary to enter the infected area.

This operation has now been used by the author in thirty-one cases with very satisfactory clinical and functional results in all cases. (Table I.) In each case X-rays taken a few months after operation show the grafts firmly in place, and those taken several years later reveal marked proliferation and illustrate well the strong bridging support which this type of extraarticular

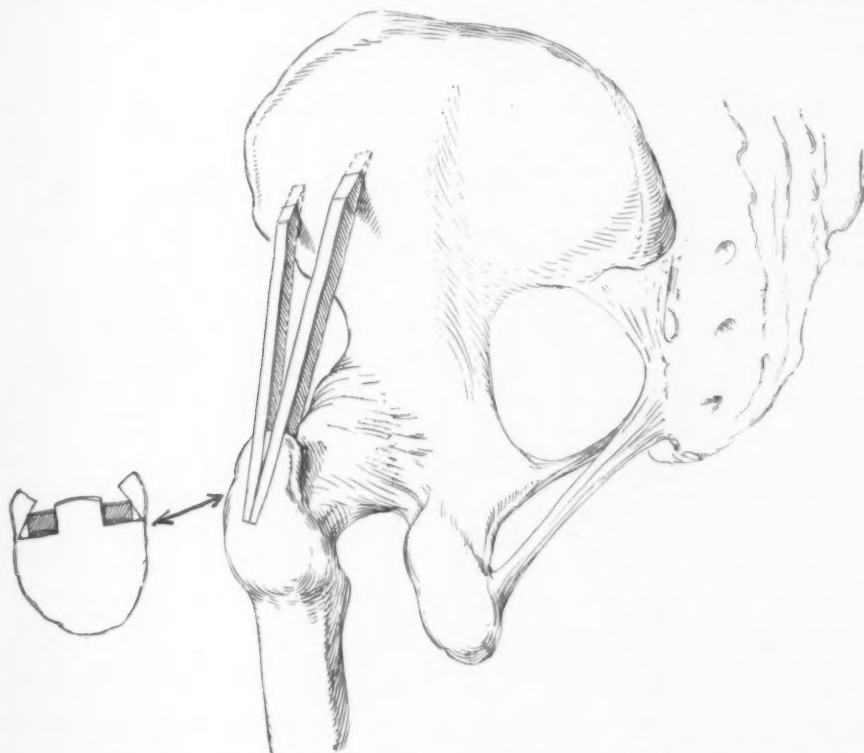


FIG. 1.—Technic for extraarticular arthrodesis, in cases where destruction is moderate. Tibial grafts are carefully mortised into the great trochanter and the side of the pelvis, forming a strong bony bridge. (Group 1a.)

arthrodesis affords. (Fig. 1.) These cases have been followed from one to twelve years post-operatively, with an average of six and one-half years.

FOUR VARIATIONS OF TECHNIC ADAPTED TO VARYING DEGREES OF DESTRUCTION

In an extensive experience with extraarticular arthrodesis of the hip during the past thirteen years, the author has been convinced more and more that it is distinctly advantageous to the surgeon to have more than one type of operation to select from in meeting the variety of mechanical requirements which I have above discussed. Any proposed extraarticular arthrodesis is best brought about between the great trochanter on one side of the joint and the side of the ilium just above the rim of the pelvis on the other, and since the proximity of the trochanter to the side of the pelvis and the

rim of the acetabulum varies widely in accordance with the degree of joint destruction, limb adduction and flexion, the operative technic must vary accordingly. As in every surgical procedure, the simplest technic associated with the minimum of trauma and shock to the patient should be chosen, and also one which will the least interfere with a future arthroplasty, should the latter be desired and prove feasible. (See Case 7.)

From the technical standpoint cases suitable for extraarticular arthrodesis of the hip can be divided into two groups, on the basis of pathological

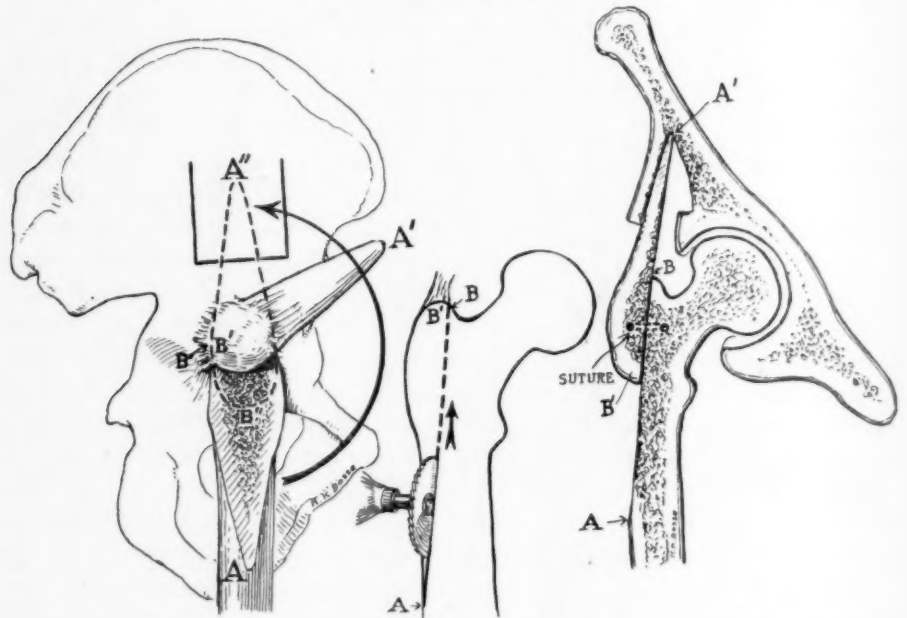


FIG. 2.—Technic for Group 1b. Hibbs or Hass technic modified so that it is really extraarticular.

findings, and each of these subdivided into two types, as to the character of operation.

Group 1.—In the first group the destruction is moderate in amount and the great trochanter remains widely separated from the side of the pelvis, so that a bone graft cannot be obtained from the side of the ilium or the immediate locality in sufficient length and strength to serve as a bridge for the extraarticular arthrodesis. Therefore the surgeon is compelled to go to the tibia or the outer portion of the upper end of the femur for graft material, because of the necessity of obtaining not only long but strong grafts.

Operative Technic for Group 1a.—The patient is anesthetized to muscular relaxation and placed upon the fracture-orthopaedic table. The surgeon forcibly corrects the adduction of the diseased hip by manual counter-pressure, placing one hand against the buttock and the other against the inner aspect of the knee. His assistant at the same time, by adjusting the fracture-orthopaedic table, places the well leg in the limits of physiologic abduction, and cautiously swings into a position of abduction the traction

ARTHRODESIS OF HIP FOR TUBERCULOSIS

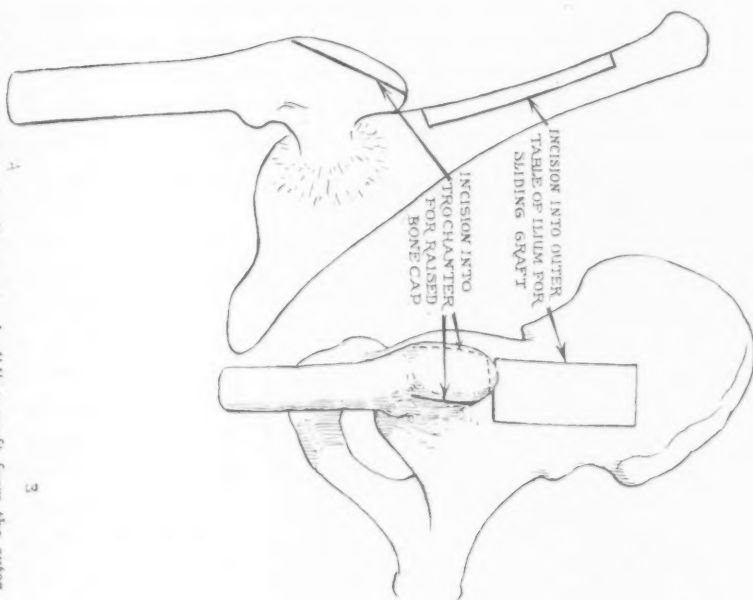


FIG. 3.—Technic for Group 2a. A sliding graft from the outer table of the ilium is mortised into the trochanter.

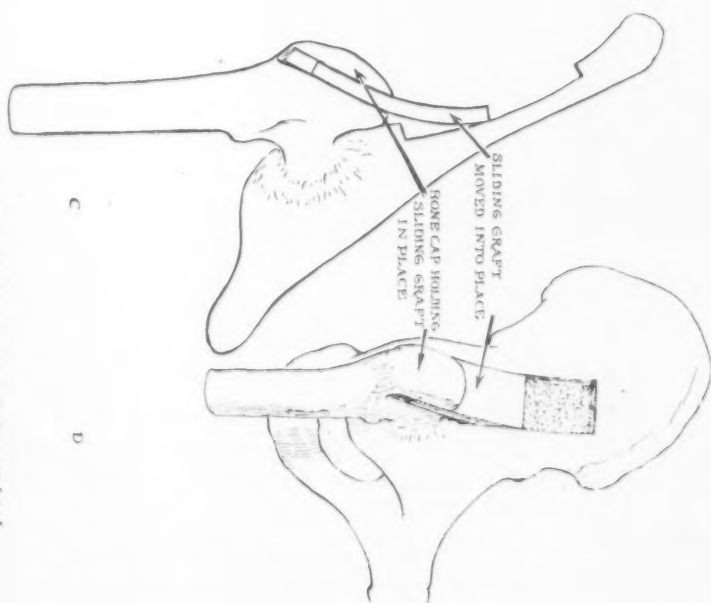


FIG. 4.—Same as Fig. 3 with technic completed.

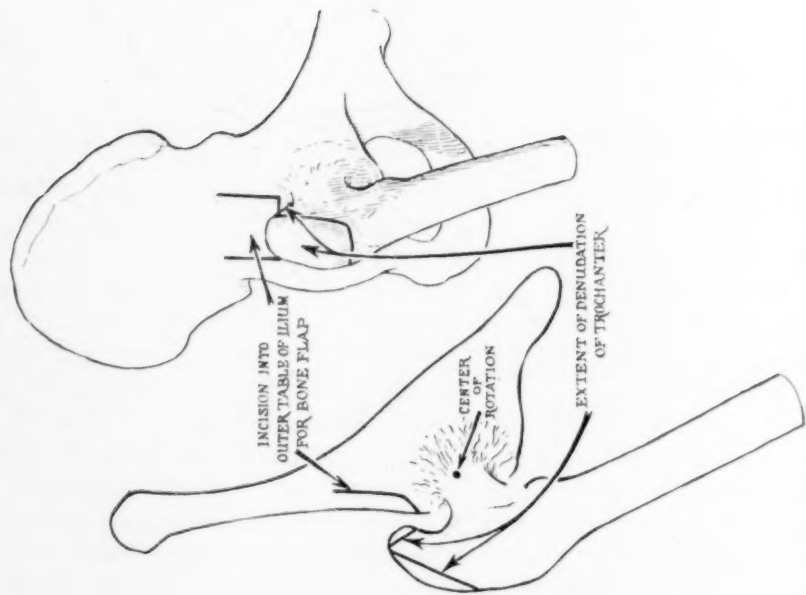


FIG. 5.—Technic for Group 2b. This is applicable only in rare cases in which the trochanter is practically resting against the side of the ilium, and all tuberculous tissue has been previously removed during unsuccessful attempt at intraarticular arthrodesis.

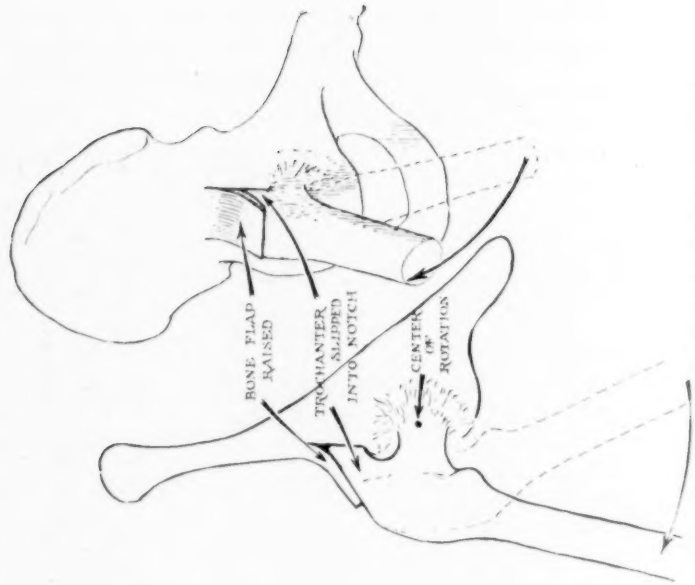


FIG. 6.—Same as Fig. 5 with technic completed.

ARTHRODESIS OF HIP FOR TUBERCULOSIS

arm of the table holding the diseased leg. The amount of abduction in which the latter is placed depends upon the amount of bony shortening. This method of correction, partly by mechanics of the table and partly by manual pressure, is adopted in order to guard against overstretching the lateral ligaments of the knee-joint.

A somewhat curved incision starting at the crest of the ilium, two inches posterior to the anterior-posterior spine and carried down below the great trochanter, is made through the skin. The gluteal muscles are separated sufficiently to expose the side of the ilium at the points of mortise for the insertion of the proposed tibial grafts.

Because of the thinness and elasticity of the bone comprising the outer table of the ilium, a mortise suitable to receive the grafts can be satisfactorily made with a half-inch chisel driven through the outer table of the ilium obliquely upward between it and the inner iliac table, with the handle of the chisel in close proximity to the trochanter. With the cutting end of the chisel still in the mortise prepared by it, located one inch posterior to the anterior-superior spine, and one inch below the crest of the ilium, the handle is depressed onto the outer surface of the trochanter at its anterior border, and used as a guide for some cutting tool, such as the scalpel, to mark on the periosteous structures the line where the motor saw is later to prepare a gutter for graft No. 1.

The same preparation is made for graft No. 2, except that the mortise in the ilium is made about one and one-half to two inches posteriorly to the first one, and the scalpel mark is made on the posterior outer surface of the great trochanter.

Saw cuts are now made one-half inch in depth with the motor saw, fol-



FIG. 7.—X-ray taken eight years after operation (Case 1). Note proliferation of tibial grafts, especially at trochanter end where mechanical stress is greatest. When inserted the grafts were the same diameter throughout. This patient was operated on thirteen years ago and the result is excellent.

lowing the scalpel marks just made on the trochanter. With an osteotome driven into these saw cuts, fragments of the trochanter are displaced with the periosteous soft parts as hinges, anteriorly from the saw cut for graft No. 1 and posteriorly from the saw cut for graft No. 2, so as to produce gutters to receive the two grafts.

The anterior internal surface of the tibia is then laid bare from the tuberosity of the tibia downward. With the motor twin saw set with the blades



FIG. 8.—Post-operative X-ray, Case II.

approximately five-eighths of an inch apart, a graft is removed by saw cuts made downward from the tuberosity of the tibia about nine inches. With a small motor saw, this strip of bone is then cut into two segments. The upper ends of the grafts are cut in an oblique way like the end of a chisel.

The upper end of graft No. 1 is inserted into the mortise of the ilium with its lower end lying in the anterior gutter prepared in the trochanter. The oblique surface at the upper end is outward. With the author's bone drift or set (of which the carpenter's nail set is the prototype)

placed on the trochanteric end of the graft, the graft is now driven into the iliac mortise. (Fig. 1.) In this manner its trochanteric end is made to slide along the trochanter gutter and its proximal end to penetrate the mortise of the ilium by means of blows of the mallet upon the bone set.

Graft No. 2 is put in by precisely the same technic. The firmer the grafts are driven into the iliac mortise, the closer do they hug the bottom of the trochanteric gutter because of the obliquity of the cut end of the iliac end of the graft. This plan of operation automatically immobilizes the grafts at both ends in a most gratifying way and no immobilizing bone ligatures are necessary. (Fig. 1.)

The soft parts with fragments of the trochanter are drawn over the ends of the graft by means of interrupted strands of medium kangaroo tendon. The gluteal muscles are carefully drawn about the grafts by means of chromic catgut sutures.

ARTHRODESIS OF HIP FOR TUBERCULOSIS

The skin is closed with continuous suture of o plain catgut. Suture holes and the edges of the wound are puddled with three and one-half per cent. tincture of iodine.

Technic for Group 1b.—The upper portion of the approach for this procedure is very similar to that described when tibial grafts are used. In this instance the incision must extend generously downward so as to give free exposure of the antero-external aspect of the upper end of the femur (extending downward from the tip of the trochanter for five inches). The soft structures are separated, leaving the periosteum on the femur. With the motor saw and sharp one-half-inch osteotome, a strong graft about five inches long and comprising about one-fifth the diameter of the shaft of the femur from the tip of the great trochanter downward is obtained with a pedicle of muscle at its upper end. The lower end (See Fig. 2) of the femoral graft is now swung anteriorly on the muscle and soft tissue pedicle at the upper end as an axis until its anterior end comes in contact with the side of the ilium. When the desired location on the ilium is thus determined a flap or door of the outer table of the ilium is turned



FIG. 9.—Post-operative X-ray, Case III. The two grafts are superimposed so that only one is apparent.

slightly upward and backward by means of the motor saw and half-inch osteotome, so that the upper end of the graft (formerly the lower end) can be thrust backward beneath it. (See Fig. 2.) Bone fixation ligatures are not necessary, as when the graft is jammed with a few blows of the mallet and bone drift it is firmly placed and will not be displaced. The muscles and fasciæ are now replaced over and around the graft with continuous suture of chromic catgut, and skin closed in the usual way.

The Hass or Hibbs procedure is somewhat similar to this method,

except that Hibbs' method is not truly extraarticular, as both his diagrams and the description of his technic show that the neck of the femur is exposed and the cortex removed. The operation is therefore necessarily within the tuberculous area, which is to be avoided. Furthermore, it requires an extensive operative field, wide resection of muscles, and much shock. One should recall in this connection Cannon's findings that extensive muscle trauma is a most potent influence in producing shock. The procedure



FIG. 10.—Post-operative X-ray, Case IV.

is the most difficult of the four types of technic presented. The author has so modified this operation that it is extraarticular, but the great trochanter and attached muscles are much more damaged than when the tibial grafts are used, and leaves more unfavorable conditions for a future arthroplasty—a possibility which should always be borne in mind in planning an arthrodesis. (See Case 7.)

Post-operative Dressing.—Extensive dressings of gauze and sterile cotton are applied, and then a plaster-of-Paris spica from above the costal margin to the base of the toes on the operated leg, and to below the knee-joint of the opposite leg, in a posture of abduction sufficient to overcome practical shortening.

With the plaster still in a semi-plastic state, it is carefully molded over the operated area, for two purposes: to favor immobilization, and to aid in the control of bleeding.

The plaster on the uninvolved leg is removed at the end of five weeks. The remainder of the plaster is left alone until ten weeks from the time of operation.

Technic for Group 2a and b—Group 2 is illustrated by Figs. 3, 4, 5, and 6. The head and a large portion of the neck of the femur have been disintegrated with telescoping, causing the trochanter to become more or less closely approximated to the superior rim of the acetabulum and the side of the pelvis.

ARTHRODESIS OF HIP FOR TUBERCULOSIS

For convenience in discussing the operative technic this group may be subdivided into two types:

Group 2a comprises those cases in which the destruction has been so extensive that the trochanter has approximated the rim of the acetabulum to a sufficient degree—within one-half inch or less—so that a sliding graft from the outer table of the ilium (Fig. 3) is adequate to reach from the side of the ilium into the trochanter and also furnish adequate contact with these bony elements and still allow the surgeon to keep outside the tuberculous joint. The side of the ilium has already been laid bare by the Smith-Petersen approach and furnishes a very satisfactory graft in that this outer table is not only curved so that it approximates the trochanter and ilium satisfactorily (Fig. 4), but also enables the surgeon to secure as broad a graft as he wishes. This technic is somewhat less difficult of execution and consumes less time than obtaining a graft from the tibia or femur, as described under Group I. The surgeon, after sizing up the mechanical conditions, may therefore choose this type of technic rather than the other two already described.



FIG. 11.—Post-operative X-ray, Case VI. Note complete absence of head and neck, both because of destruction by disease and operative removal at previous unsuccessful attempt at intra-articular arthrodesis by prominent orthopaedic surgeon.

In certain extreme cases, Group 2b, in which the trochanter is practically resting against the side of the ilium, and in which an intraarticular arthrodesis has been previously attempted, with complete removal of all tuberculous tissue, the following simple technic may be used: The trochanter may be denuded of its periosteum and periosseous structures, both on its outer and inner surfaces. The outer table of the ilium just above the acetabular rim is then lifted externally, and the denuded trochanter implanted beneath the latter by swinging the hip into the abducted posture which automatically elevates the trochanter into the crevice thus made. (Figs. 5 and 6.) It may be necessary to supplement this procedure by implantation of a graft obtained from the outer table of the ilium, higher up near the crest. These very extreme cases are rare; the author has encountered only two of this type. This technic is partially intraarticular.

In any event one should design the operative procedure so that the graft used will be firmly mortised into both femur and pelvis without entering the tubercular joint, and it will have to be left to the judgment of the surgeon as to just what technic should be chosen, always remembering that the simplest technic feasible will be most satisfactory.

Either of the procedures described under Group 2 is easier of execution than those for Group 1, providing the trochanter is near enough to the side

of the pelvis so that it can be well carried out.

Indications for Operation.—Extraarticular arthrodesis is indicated, preferably in older children or adults, (1) whenever there is constant relapse of the abduction deformity in spite of conservative measures to overcome it, such as traction in bed, braces, etc., after long periods of such treatment. (2) If the abduction deformity recurs following Gant's osteotomy, because of the hip not being completely ankylosed. (3) If the X-ray reveals marked destruction of the head or acetabulum, or both. (4) If there are symptoms of active tuberculosis. (5) In adults even if the bone



FIG. 12.—Post-operative X-ray, Case VII. Arthroplasty four years after arthrodesis by technic 1a. Note grafts from previous arthrodesis.

destruction is moderate. The advantages of extraarticular arthrodesis for advanced tuberculosis of the hip with destruction is well illustrated by the author's first case.

Relative Difficulties of Technic.—The simplest technic is 2b, but for the reasons already discussed it is applicable only in rare instances.

Where the great trochanter is in close proximity to the rim of the acetabulum, the simplest bone-graft operation possible for extraarticular arthrodesis is applicable: the sliding down of a broad graft from the outer table of the ilium into the split trochanter (2a).

The tibial grafts (1a) are next in order of difficulty.

The most difficult operation, particularly as to extent of operative field and tissues involved, is 1b, the modification of the Hass or Hibbs technic. The original Hass-Hibbs operation is not extraarticular, but about four or

ARTHRODESIS OF HIP FOR TUBERCULOSIS

five inches of the outer portion of the great trochanter and the shaft of the femur can be used to accomplish an extraarticular arthrodesis. This, however, is an operation of great magnitude in that an incision has to be made from just below the crest of the ilium to nearly one-third down the thigh in order to rotate the graft into position (Fig. 2).

Caution.—A word of caution concerning the execution of bone-graft technic is stimulated by recent observation of a lantern slide reproduction of post-operative results elsewhere, in which it was claimed that extraarticular arthrodesis of the hip had been accomplished, but with unsatisfactory results in a considerable percentage. The X-rays in the slides showed that the same inadequate and imperfect technic had been practiced as has been so frequently observed during the past eighteen years when certain surgeons have drawn unfavorable conclusions from their attempts to accomplish extraarticular arthrodesis of tubercular spines, although the operative technic was inadequately carried out. At one of our largest university medical schools a few years ago post-operative X-rays of nine grafted tubercular spines in children were shown. In only two of these cases were the grafts long enough or properly inserted. Nevertheless deductions were drawn from the nine cases, as to the efficacy of the bone graft in the treatment of tubercular spines. Therefore the author wishes to emphasize the necessity of the graft being of sufficient strength, ample length, accurate fit, and carefully mortised on either side of the joint if good results are to be secured. Carelessness in technic will obviously have a marked influence on end results.



FIG. 13.—Case VII. Functional result following arthroplasty of hip four years after arthrodesis.

ILLUSTRATIVE CASES

CASE I.—The patient (J. L.), a woman forty-three years of age, was first seen by me May 25, 1910, and presented all the symptoms of a typical acute tubercular hip on the right side. X-rays taken at that time confirmed the diagnosis.

The patient was immediately fitted with a Phelps brace with a high shoe on the left foot, and crutches. This brace served to immobilize and to relieve the hip from weight-bearing. It was worn for two and one-half years and then removed; but because of pain, the patient was unable to get along without it, and so the brace treatment was resumed.

In October, 1915, the patient claimed that her symptoms were more severe than when we had begun the brace treatment five years before. X-rays showed considerable destruction of the acetabulum and head of femur.

During this whole period the writer had been producing an extraarticular arthrodesis of the spine by inserting autogenous bone grafts into the spinous processes, with

excellent results. It therefore occurred to him: "Why not apply the same principle to the tuberculous hip where the mechanical, pathological, and surgical difficulties of intra-articular arthrodesis are so great?" The matter was discussed with the patient, and she was perfectly willing to undergo such an operation.

October 30, 1915, at Post-graduate Hospital, New York City, the operation was done under a general anaesthetic, with the patient on the fracture-orthopaedic table. After the adduction had been corrected, two strong tibial grafts (each about four and one-half inches in length and five-eighths inch in width) with the full thickness of the periosteum, cortex, and whatever marrow substance clung to the graft (Fig. 1) were mortised into the side of the pelvis and into the trochanter, the grafts coming together at the



FIG. 14.—Same case as Fig. 13.

trochanter like the rafters of a pitched roof. These grafts were obtained with the author's twin-motor saw. One long graft was secured from the antero-internal surface of the tibia with the twin saw, and cut in the middle to provide two grafts.

Upon discharge from the hospital the patient was immediately admitted to the Burke Foundation Convalescent Home at White Plains, N. Y. Although she had had a very stubborn tubercular hip, she made such an excellent recovery that she was taken on as a practical nurse and helper at the Convalescent Home. A letter received from her in the spring of 1926 indicates that the result is brilliant. She stated that she was still working as a nurse, and had no symptoms in her hip whatsoever. These grafts were obtained from the tibia with the twin-motor saw, and when obtained were of the same diameter throughout.

The X-ray (Fig. 7) ten years after insertion of the grafts demonstrates in a very striking way the influence of stress upon their growth. Inasmuch as the nearer the trochanter, the greater the stress, the grafts have become conical in shape with the largest diameter near the trochanter.

ARTHRODESIS OF HIP FOR TUBERCULOSIS

CASE II further illustrates the advantages of this treatment. A young woman (H. F.), aged eighteen years, consulted me in September, 1920. For ten years she had been suffering from a tuberculous hip. In 1914 symptoms disappeared but left the limb in a marked adducted posture with incident shortening. To relieve this she was taken to a hospital in 1916, and, under an anæsthetic, the adduction overcome and a plaster-of-Paris cast applied, which she wore for three months. Upon removal of the cast the old symptoms recurred, and with them the adduction relapsed.

She was brought by her family to me for two purposes: for the relief of symptoms at the hip, and for correction of the adduction and practical shortening.

X-rays showed a marked degree of destruction in the hip-joint, and my examination confirmed the presence of active tuberculosis.

An operation precisely similar to that described under Group 1a was performed (Fig. 8), and the result has been most satisfactory, the symptoms and the adduction having been completely controlled.

The hip is indeed the most favorable monarticular joint in the whole body for function following arthrodesis, because of the very efficient compensatory motion at the lumbar spine and knee.

CASE III.—J. H., a man of forty-five, complained of lameness, pain, stiffness and limited motion at the hip, and weakness following use. These symptoms had persisted for six years, during which he had been treated elsewhere by medication and by osteopathic manipulations.

Extraarticular arthrodesis (1a) was performed by the author July 11, 1917, and the result was very satisfactory. (Fig. 9.) All symptoms have disappeared.

CASE IV.—A. W., a girl sixteen years of age, had had symptoms in her hip for three years. Motion was exceedingly limited. X-rays showed considerable destruction of the acetabulum, and the head and a portion of the right femur were completely destroyed. She had worn a cast for two and one-half years and walked with crutches.

At operation, December 10, 1923, marked destruction of the hip was found. Operation of the type described in Group 1a was carried out. The result has been most satisfactory. The X-rays (Fig. 10) show proliferation of the grafts. The patient can walk two miles without fatigue, and with no support of any kind. She also swims.

This case demonstrates to a very unusual degree the general characteristics of the pathology of tuberculous bone and joint disease, namely, the pronounced amount of bone destruction with practically no coincident bone repair or bone proliferation (Fig. 10). This is peculiar to the tubercle bacillus in that in the case of every other chronic infection there is a corresponding amount of bone repair and bone proliferation going on coincidentally with the bone destruction.



FIG. 15.—Same case as Fig. 13.

CASE V.—M. M., a housewife thirty years of age, had been unable to walk without support for five years on account of pain in the left hip. She was at first told that she was suffering from rheumatism and was treated for this. She was then put to bed and a spica applied, which was left on for one year. Sunlight treatment was also given. When seen by us the patient had been in bed fifty months.

Examination showed one inch actual shortening of the left leg. There was marked pain in the hip upon any movement, especially on rotation of the head of the femur. Considerable muscle spasm was also noted around the joint.

X-rays revealed marked erosion of the left acetabulum with marked bony destruction. The head of the left femur was very much eroded, and areas of bone destruction

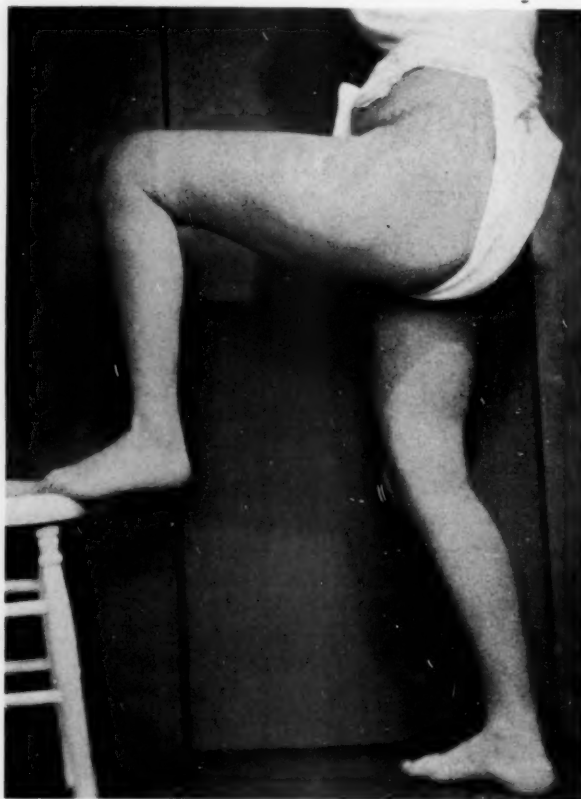


FIG. 16.—Same case as Fig. 13.

were noted over the entire head of the femur. The neck of the femur was approximately one-half that of normal size, and there was marked bone atrophy of the whole upper half of the left femur. She had a temperature of 100.3° and had been running a temperature around 100° for the past two years.

A diagnosis of tuberculosis of the left hip-joint was made, and operation undertaken January 10, 1927. A large tuberculous abscess about the size of a large lemon was attached to the anterior-inferior surface of the joint capsule. This was not incised or drained. The technic described under Group 2a was carried out, the greater trochanter being split longitudinally downward with a broad osteotome for about one and one-half inches, and a graft slid down from the outer table of the ilium into the groove previously made in the trochanter. The muscles and skin

were then closed in the usual way, dressings applied and a spica cast put on, extending from two inches above the umbilicus to the toes. The operation took one hour.

In this case 500 cubic centimetres of normal saline solution was given subcutaneously immediately following operation, and 500 cubic centimetres intravenously six hours later, as the patient's resistance had been greatly lowered by the long-standing infection and so many years in bed. She reacted well. The cast was removed in three months, and the wound had healed perfectly. X-rays taken at this time showed the graft in place. The patient had gained fifteen pounds and had had no pain or discomfort. Another cast was applied, and left on until June 1, after which the patient wore a Phelps brace.

The patient was last seen in February, 1928, when she was in excellent condition, walking without brace, cane, or crutch.

CASE VI.—R. D., a young woman of twenty-eight, has a very interesting history.

ARTHRODESIS OF HIP FOR TUBERCULOSIS

She had had trouble with her hip since she was five years old. For two years she was in bed with casts and braces. She then went without treatment for seventeen years, and got about with limited motion. In April, 1916, pain began again and prevented walking. She was given X-ray treatments in Arizona and, when these failed, was sent to a prominent orthopaedic surgeon of Los Angeles, who put her in a plaster cast for four months. In January, 1917, he decided to operate and performed an intraarticular arthrodesis. Following this operation the patient received heliotherapy, and was able to get about with a cane; but active symptoms persisted, ankylosis not having been secured. Such failure following intraarticular arthrodesis would occur in a large percentage of cases, because of the inhibition of osteogenesis by tubercle bacilli and the recession of bony surfaces.

In March, 1918, she came to the author, with increasing adduction deformity. X-rays showed marked destruction of the acetabulum, with complete destruction of the head and most of the neck of the femur.

An extraarticular arthrodesis was performed at Postgraduate Hospital, a bone graft being taken from the crest of the ilium (2a.) (Fig. 2.) Following the operation the leg was immobilized in moderate abduction by means of a long plaster spica. The pathological report was tuberculous osteomyelitis and periostitis.

CASE VII.—G. B. This patient first consulted me in 1923, when she was eleven years old. She had then had trouble with her hip for five years, with much pain, limited motion, and a tendency to adduction and inward rotation. During these five years she had been under conservative treatment, wearing a Phelps brace day and night. Weights on the bed had also been applied, but the symptoms did not subside. X-rays showed considerable destruction of the acetabulum and head of the femur.

November 8, 1923, I performed an extraarticular arthrodesis of the hip, with two massive bone grafts from the tibia, the adduction deformity not being corrected for fear of reactivating the disease. The cast remained on for ten weeks, after which massage was instituted. In February the patient went home on crutches. In May she began walking without cane or crutch.

In 1925 all symptoms had subsided, but there were two inches of practical shortening, and three-fourths of an inch of actual shortening. In September, 1926, the practical shortening was overcome by means of a circular Gant's osteotomy. Following this operation the leg was put up in moderate abduction for eight weeks. Then massage was given for one month. Her parents then requested that while she was still in the hospital an operation be done to correct the marked knock-knee which was a result of the early, long-continued brace treatment of her hip, and which she had had ever since the adduction deformity developed.

A supracondylar osteotomy was therefore done, and the deformity held in over-correction by means of a hip spica including the foot. This was left on for eight weeks. The correction and result were excellent.

In the summer of 1927 she went to camp, the extremity functioning very well. In September she returned to me again for a check-up examination. The knock-knee was entirely corrected, and her physical condition was so good that her mother suggested the possibility of an operation for motion at the hip, particularly as the patient was beginning to object to the awkward position which she was obliged to assume in sitting. The family were impressed with the risk of operating upon an old tubercular hip.

An arthroplasty of the hip was done September 19, 1927. Following the operation the hip was in a cast for three weeks with traction. After its removal massage was started, but traction continued. The patient was discharged from the hospital November 20, traction and massage being continued at home.

December 1 a limited amount of weight-bearing was permitted, and this was gradually increased. January 10 she discarded the crutches and used a cane. Late in January traction was discontinued.

The patient returned to school February 1 and on Washington's birthday went to Atlantic City, where she swam 120 feet in a pool.

March 15, six months after the arthroplasty, she had ninety degrees of normal painless motion in all directions. She is walking nearly a mile a day without a cane. All symptoms have subsided and she has only a slight limp. This case is a striking example of the possibilities of reconstruction surgery, and further emphasizes the importance of selecting a technic that is completely extraarticular and causes a minimum of damage to the musculature about the hip. In other words, one should formulate the arthrodesis procedure in such a way as to afford the most favorable conditions for a future arthroplasty for mobility. The technic used in this case, with tibial grafts, has distinct advantages in this respect. (Fig. 12.)

CASE VIII.—B. F., a girl of seventeen years, had fallen while running on a stone floor, ten years before our examination. During this ten years she had been treated by the best orthopaedic surgeons in England by various conservative measures, including traction, plaster casts, Thomas splint, and heliotherapy, with absolute failure to relieve symptoms, or to overcome the adduction deformity.

X-rays showed old tuberculosis of the hip, with moderate destruction.

March 5, 1925, at Postgraduate Hospital, an operation of the type described as Group 1b, with a graft from the trochanter, was done. The result was very satisfactory.

This case is particularly interesting in view of the continued failure of conservative measures.

MORTISED GRAFTS VERSUS CHIP GRAFTS—THEIR RELATIVE MERITS

As a result of extensive animal experimentation and experience in the use of the bone graft during the last eighteen years in arthrodesis of the hip and other joints by both extra- and intraarticular methods, I have been convinced of the necessity of using strong grafts well mortised into both bone elements on each side of the joint. Numerous irregular shaped grafts packed around the periphery of the joint are not trustworthy in view of the fact of Nature's tendency to restore mobility in a joint. In many instances in cases operated on by others and some operated on by myself by the chip-graft method, I have had to reoperate in the spine, hip, and other joints after the failure of the so-called "fusion" operation where only unmortised chips of bone were used, even though complete intraarticular removal of cartilage from both head of femur and acetabulum had been done in favorable osteoarthritic cases.

In evaluating osteogenetic possibilities at the operating table one should, for the sake of safety, consider them to be the lowest rather than the highest; for there is, unfortunately, no way of measuring pre-operatively in a given case the osteogenetic factor, which varies widely with individuals. To allow the largest possible margin of safety, it is therefore wise to plan every bone operation as if it were the case with the lowest potentiality of callus formation.

If one assumes that the patient has a moderate or high degree of osteogenetic potentiality and plans his operative procedure on this assumption, he may be doomed to disappointment, finding post-operatively that in this particular case the osteogenetic factor was extremely low, and too much had been left to Nature. If the graft had been accurately mortised even a low

ARTHRODESIS OF HIP FOR TUBERCULOSIS

degree of osteogenesis would have been sufficient to produce ankylosis, and the desired result would have been attained.

In May, 1907, at Postgraduate Hospital I supplemented an intraarticular arthrodesis for osteoarthritis in a male adult by placing extraarticularly, around the periphery of the joint, chip grafts.† Subsequently the author used this chip-graft method in a large number of cases of osteoarthritis, a condition that is far more favorable to the securing of ankylosis by surgical operation than bone tuberculosis because the inhibitory influence of the tubercle bacillus on osteogenesis is not present. But even under these most favorable conditions, there were occasional delayed unions or arthrodeses and failures to secure arthrodesis in cases in which chip grafts were used, so that for the past ten years I have employed the mortised graft instead of the chip grafts exclusively for all types of operation, using chip grafts only to supplement the inlay, peg, or mortised graft.

In view of the unfavorable results too often obtained when chip grafts are used to supplement extraarticular and intraarticular arthrodesis, the untrustworthiness of primary extraarticular arthrodesis by means of such grafts, as in cases of tuberculosis, is apparent and the advantages of massive, carefully mortised grafts are easily appreciated.

These advantages may be briefly stated as follows:

1. The massive mortised grafts have a marked influence toward producing immobilization from their internal splint action.
2. They serve as a continuous vascular conducting scaffold from one side of the joint to the other, the first and most important requisite for bridging callus formation.
3. They bring about a very close apposition of the graft tissues to the host tissues, thus furnishing the most favorable conditions for the establishment of blood circulation from host tissue to graft tissues.

The importance of this has been recently emphasized in a most striking way by research work done by Bohlman and Johnson at Johns Hopkins University, which shows that osteogenesis has an immediate and definite relationship to blood supply, the establishment of which must precede osteogenesis.‡

In other words this whole consideration is a biological one, and much can be learned in an operative way from the study of grafts when applied in the vegetable kingdom. The scientific foundation for the inlay mortised grafts as compared with the haphazard chip grafts is obvious.

In cases in which a second operation became necessary following intraarticular arthrodesis with extraarticular chip grafts done by myself and by others, and in spinal cases where chip grafts had been used elsewhere to "fuse" the spine, the author has been able to check up at reoperation as to

† Albee: Jour. Am. Med. Assn., June, 1908.

‡ Johnson, Robert W.: A physiological study of the blood supply of the diaphysis. Jour. Bone and Joint Surg., 1927, vol. ix, p. 153; Bohlman, personal communication.

the condition of these chip grafts, and has been impressed by the fact that no one can foretell individual osteogenetic potentialities.

In many instances of both hip and spine I have found the chip grafts lying in place without any two of several dozens having united. In one such case of spondylolisthesis on which the author operated recently in which a chip-graft fusion had been attempted a year and a half before by a prominent advocate of the fusion operation, I was unable to find union of any two of the chip grafts when I laid bare the field. Undoubtedly this was a case of low osteogenesis. X-rays taken May 1, 1928, five months after my operation, show the massive mortised graft to be firmly united, in spite of the low osteogenetic factor. Further complete relief of all symptoms has resulted from the massive inlay graft operation. It might be mentioned in passing that in many instances it is impossible to determine by X-ray whether or not fusion has resulted from the insertion of chip grafts.

I wish to combat the statements repeatedly creeping into the literature that accurate mortising work by electric bone mill technic can only be accomplished "at the cost of considerable time". The time-consuming factor is not the mortising, but the hesitancy and lack of experience of an operator who has not taken the pains to perfect himself in motor technic. Many an otherwise able surgeon is unfortunately a novice, or still in the stage of internship, when it comes to the use of electrical instruments, and his lack of skill with the rapidly moving tools causes a hesitancy which is indeed time-consuming. Once the surgeon has made himself as familiar with these machine tools as he is with his knife and osteotome, it certainly does not take more time to cut an accurately shaped bone with automatic machine tools than to chip it with hand instruments. Extraarticular arthrodesis of the hip as performed by the author is completed in from thirty to forty minutes.

To the frequently recurring argument regarding the relative merits of chip grafts and mortised grafts, advocated with equal enthusiasm by opposing schools, there is but one answer, the biologic considerations and the end results in the hands of those surgeons who have equipped their operating rooms and trained themselves in both types of technic so that the end results are really comparable. The author has had much experience with both types, and for the reasons already set forth in this paper, finds the evidence—experimental, biologic, and clinical—strongly in favor of the carefully mortised graft.

That the general surgeon who only occasionally is called upon to do bone-grafting work, and is rarely equipped for or experienced in doing mortised inlay work, may well be tempted to use the chip-graft method I can readily understand. But the orthopædic or bone surgeon should not ignore the speed, precision and delicacy of technic which the mastery of electrically driven automatic bone-cutting machine tools alone affords.

ARTHRODESIS OF HIP FOR TUBERCULOSIS

TABLE I.
31 Cases of Extraarticular Arthrodesis of the Hip with End Results.

Case	Age	Duration of symptoms	Symptoms	Previous treatment	Our treatment	Result
1. B. F.....	17	10 yrs.	Fixed flexion adduction deformity.	Traction; plaster cast; Thomas splint; heliotherapy.	Extraarticular arthrodesis, 3/5/25.	Very satisfactory; good function.
2. H. F.....	18	9 yrs.	Pain and weakness in hip; adduction deformity.	Splint; high shoe; prolonged rest in bed; stretching under anesthetic to overcome adduction. (Relapsed.)	Extraarticular arthrodesis, 9/11/20.	Pain relieved. Function of leg very satisfactory.
3. A. W.....	16	3 yrs.	Limited motion; uses crutches; marked destruction of hip.	Cast for two and one-half yrs.	Extraarticular arthrodesis, 12/10/23.	Good function. Swimming; walks 2 miles.
4. L. G.....	31	26 yrs.	Pain.	Operated on when six yrs. old; type of operation not known. Plaster cast. Brace.	Extraarticular arthrodesis recommended.	Refused operation.
5. H. N.....	12	Not stated.	Pain.	Brace (had had bone graft for Pott's disease).	Extraarticular arthrodesis, 4/7/22.	Good.
6. R. R.....	12	8 mos.	Limited motion; shortening.	Traction; brace; cast.	Extraarticular arthrodesis, 3/24/27.	Good.
7. J. S.....	13	10 yrs.	Limp; pain; night cries; limited motion.	Rest in bed; extension; cast.	Extraarticular arthrodesis, 11/4/22.	Excellent.
8. N. L.....	43	5 yrs.	Pain and inability to walk.	Brace for two yrs.	Extraarticular arthrodesis, 10/30/17.	Excellent. Gained 30 lbs. after operation.
9. J. L.....	13	6 yrs.	Pain; night cries.	Extension with weight; brace two yrs.; plaster cast.	Extraarticular arthrodesis, 6/1/18.	Excellent.
10. J. H.....	45	6 yrs.	Lameness; pain; stiffness; limited motion; weakness following use.	Medical, and osteopathy.	Extraarticular arthrodesis, 7/11/17.	Good.
11. A. G.....	?	13 yrs.	Pain; limp; walks with cane.		Extraarticular arthrodesis recommended.	Refused operation.
12. W. R.....	27	9 yrs.	Pain; weakness; uses crutches; almost complete destruction femoral head.	Operation for bow legs.	Extraarticular arthrodesis, 2/24/18.	Good.
13. E. E.....	? child	4 yrs.	Pain; limp; walks with crutches.	None.	Extraarticular arthrodesis recommended.	Refused operation.
14. C. M.....	14	4 yrs.	Pain; instability.	Gault's osteotomy.	Extraarticular arthrodesis, 12/20/13.	Good. Patient is foreman of brush factory, 1926.

Extraarticular Arthrodesis of the Hip—Continued.

Case	Age	Duration of symptoms	Symptoms	Previous treatment	Our treatment	Result
15. B. S.	45	25 yrs. intermittent, 5 yrs. constant.	Walking difficult and painful.	Cast for six months before our examination.	Extraarticular arthrodesis, 12/7/16.	Good.
16. J. M.	50	7 yrs.	Walks with crutches.	Cast for two and one-half yrs.	Extraarticular arthrodesis, 4/26/18.	Excellent.
17. J. M.	4	2 yrs.	Pain and shortening; abscess.	Cast for nine months.	Extraarticular arthrodesis, 12/2/19.	Good.
18. G. B.	11	5 yrs.	Pain and limp; adduction deformity.	Phelps brace; limited motion; adduction and inward rotation.	Extraarticular arthrodesis; subsequent arthroplasty, 9/23/26.	Excellent; swam 300 yds.
19. J. W.	22	6 yrs.	Pain; unable to bear weight.	Cast at two-month intervals for past year.	Extraarticular arthrodesis, 1/17/24.	Good.
20. F. Z.	19	4 yrs.	Pain.	Stretching; manipulation; cast seven months; brace.	Extraarticular arthrodesis, 10/9/24.	Excellent.
21. M. W.	18	12 yrs.	Deformity; limited flexion.	Plaster cast; brace for five yrs.; high shoe.	Extraarticular arthrodesis, 3/27/22.	Good.
22. E. A.	27	5 yrs.	Limp; pain without brace.	Plaster cast; violet ray; brace.	Extraarticular arthrodesis recommended.	Refused operation.
23. C. H.	58	15 yrs.	Limp; stiffness; dull pain.	Massage; osteopathic treatment; baking.	Extraarticular arthrodesis recommended.	Refused operation.
24. R. P.	24	Since infancy.	Limp; shortening; slight rotation and flexion adduction.	Osteotomy.	Extraarticular arthrodesis recommended.	Refused operation.
25. H. L.	22	19 yrs.	Marked limp; slight pain; limited motion.	Bradford frame; casts seventeen wks.; braces eleven wks.	Extraarticular arthrodesis recommended.	Refused operation.
26. C. K.	16	10 yrs.	Pain and limp; easy fatigue.	Casts for five yrs.; none for last five.	Extraarticular arthrodesis, 3/19/24.	Good.
27. E. H.	24	3½ yrs.	Pain; stiffness; all motion limited; outward rotation.	Cast for five months.	Extraarticular arthrodesis recommended.	Refused operation.
28. G. D.	59	5 yrs.	Pain; shortening; difficulty in walking.	Treated for rheumatism.	Extraarticular arthrodesis, 1/12/22.	Good.
29. J. C.	29	20 yrs.	Pain on weight bearing and walking.	Cast; stretching; manipulation; diagnosed as tumor.	Extraarticular arthrodesis recommended.	Refused operation.
30. A. B.	23	14 yrs.	Pain; shortening; limp; limited motion; flexion deformity.	None.	Extraarticular arthrodesis recommended.	Oblique osteotomy done. Good result.

ARTHRODESIS OF HIP FOR TUBERCULOSIS

31. A. C.	18	1 yr.	Pain; rotation in flexion.	Strapping.	Extraarticular arthrodesis, 8/28/24.	Very good.
32. M. C.	29	20 yrs.	Walks with crutches; shortening.	X-ray treatment; quartz light; brace for six mos. Has persistently refused operation.	Extraarticular arthrodesis, 4/28/22.	Local doctor reports "remarkably good result" in 1926.
33. H. G.	35	4 yrs.	Pain; marked spasm. *	None; graft for Pott's disease.	Extraarticular arthrodesis, 3/5/25.	Excellent.
34. D. H.	4	5 mos.	Spasm of muscles; pain; easy fatigue; night cries.	Cast.	Extraarticular arthrodesis, 1/24/27.	Good.
35. F. L.	?	Not stated.	Not stated.	History incomplete.	Extraarticular arthrodesis, 3/15/18.	Good.
36. H. B.	16	8 yrs.	Limp; no pain; marked adduction deformity; uses crutches.	Plaster spica for nine mos.; abscess ruptured under cast; no discharge last five years.	Osteotomy, 10/22; extraarticular arthrodesis, 10/23.	Pair.
37. M. M.	30	5 yrs.	Pain; inability to walk; shortening; muscle spasm.	Plaster spica one yr.; rest in bed four yrs.; sunlight.	Extraarticular arthrodesis, 1/9/27.	Good.
38. R. D.	26	21 yrs.	Pain; walks on crutches.	In bed two yrs.; casts; braces; after interval of several years, casts reapplied; then intra-articular arthrodesis; heliotherapy.	Extraarticular arthrodesis, 3/25/18.	Very good.
39. S. A.	31	9 yrs.	Pain.	Electricity and liniment for rheumatism; weight; cast for three yrs.; abscess opened.	Extraarticular arthrodesis.	Good.
40. A. V. N. ..	30	5 yrs.	Pain; spasm; limp; shortening; unable to bear weight.	Treated for rheumatism and sciatica for four yrs.; no X-ray for five yrs.; in bed two months.	Extraarticular arthrodesis, 5/27.	All pain gone. Very slight limp; has gained sixteen pounds since operation.
41. L. G.	3½	7 mos.	Pain; night cries; marked muscle spasm; unable to walk.	Traction; Phelps brace; plaster cast six mos.	Extraarticular arthrodesis, 5/10/26.	Excellent.

In every case except Case 40, pre-operative X-rays revealed destruction of the acetabulum and of the head of the femur. In many instances the destruction was of marked degree. In Case 40 diagnosis uncertain.

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ASTRAGALO-SCAPHOID DISLOCATION

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IT MAY be considered not unworthy of note that relatively few cases of simple, uncomplicated dislocation at the astragalo-scaphoid joint have heretofore been recorded. The paucity of such observations is the more striking when it is realized that numerous authors both in this country and abroad have dedicated rather imposing monographs to the study of the different types of injuries which the astragalus has suffered. In the category of these injuries fracture of the astragalus and its dislocation at the ankle joint have undoubtedly held the premier rank, while other conditions seem to be far in the minority. Thus there appear to have been observed somewhat less than twenty instances of dislocation at the mid-tarsal (Chopart's) joint, while only about 139 cases of dislocation at the subtarsal joint have been reported. If the firm ligamentous attachments of the astragalus with the calcaneus be contrasted with the comparatively relaxed astragalo-scaphoid ligaments, it will seem still the more strange that so insignificant a number of luxations should have taken place in the joint through which a great part of the mobility of the tarsus is mediated.

For a long time it was seriously questioned whether simple dislocations in this joint were at all possible, though now incontrovertible examples have apparently disposed of this doubt. However, if the opinion of Gmbel who has made a careful study of the subject be accepted, there were up to the year 1911 only nine well-authenticated cases of dislocation at the astragalo-scaphoid articulation. Of these, two were subluxations: Boeckel,³ Gmbel,⁸ and seven were true complete dislocations: Chassaignac,⁵ Dubrueil,⁴ Wodarz,¹⁶ Morian,¹⁰ Rais,¹¹ Boeckel and Gmbel. The cases of Roux, Boyer, Richerand and Beever admitted by Boeckel to the group of talonavicular dislocations were criticized and rejected by Gmbel as being improperly described and classified. The cases reported in the *Lancet*,^{1, 2} that of Wells¹³ and the two cases reported by Garr,⁶ seem most certainly to suggest true astragalo-scaphoid dislocations, but their descriptions appear to be insufficiently complete to warrant their inclusion. Since 1911 several new cases have been reported to which the dignity of entry into this very exclusive circle may justifiably be granted: Goebel,⁷ von Winiwarter¹⁴ two cases, Juhel⁹ and Winter.¹⁵ There is then a list of some four or five suspicious cases and another well-established list comprising two cases of subluxation and twelve of complete luxation at the astragalo-scaphoid articulation. The following case¹⁷ is therefore to the best of my knowledge the thirteenth complete luxation thus far in the literature. But regardless of its position in the numerical category, the case here presented is the more interesting in that

it is, I believe, the first in which careful stereoröntgenograms have permitted of accurate study and description of the relationships of all the tarsal joints.

I. B., male, aged thirty-five, was admitted to the hospital March 19, 1928, following an injury to the left foot. He recounted that while working on a ladder he had lost his balance, fallen a distance of about five feet and landed with his whole weight (175 pounds) on his left foot. Though he could not remember the exact attitude of his foot at the moment of impact, he believed that the foot turned under him into supination. The patient complained of a great deal of pain directly after the injury, but under conservative treatment this had gradually diminished so that at the time of examination he was able to bear weight and even hobble a few steps without any pain. Before his admission the patient had been X-rayed by Dr. M. Pomeranz, röntgenologist to the hospital, who very clearly diagnosed the exact nature of the injury. In order to more positively exclude the possibility of other associated lesions, I requested the taking of stereoscopic plates, which were reported: "Stereoscopic examination of the left foot in the dorso-plantar position shows the following: There is no evidence of fracture of the tarsal bones. The forefoot is moderately inverted and adducted. The inner border is



FIG. 1.—Dorso-plantar röntgenogram (Stereo) showing dislocation of the astragalus, before reduction.

apparently raised. The bone structure of the cuneiforms, the scaphoid and the cuboid is somewhat obscured by the presence of an effusion. The scaphoid bears its normal relation to the internal cuneiform and the cuboid. The cuboid is in normal relationship with the os calcis and the bases of the outer metatarsal bones. The head of the astragalus, apparently dislocated from its articulation with the scaphoid, points upward and outward and rides over the cuboid and to a slight extent over the cubo-scaphoid junction. The astragalus is apparently rotated slightly outward about its vertical axis, but appears to be in normal relationship to the articular surface of the os calcis.

"Stereoscopic examination of the left foot in the lateral position shows but slight changes from that seen in the dorso-plantar position. The calcaneo-cuboid articulation appears to be normal, as does the astragalo-calcaneal and the scapho-cuneiform. The astragalus appears to be in its normal relationship with the tibi, fibula and the os calcis, but appears to be rotated slightly outward in the horizontal plane.

"From these stereograms, it would appear that the tibio-tarsal, the astragalo-calcaneal, the calcaneo-cuboid, the cubo-scaphoid and the scapho-cuneiform joints are in their normal positions. *The dislocation appears to have taken place solely in the astragalo-scaphoid joint.*" (Fig. 1.)

When seen at the hospital the patient presented what are believed to be signs typical of an astragalo-scaphoid dislocation. The foot was held in marked varus and was so swollen that of the bony landmarks only the external malleolus was visible. The color,

ASTRAGALO-SCAPHOID DISLOCATION

the vascular pulsations, the sensory and the motor power of the foot were apparently good. The foot, however, was in a fixed varus. Extension and to a lesser degree plantar flexion, and inversion, could be carried out. Eversion was impossible. The head of the astragalus could be palpated beneath the skin pointing upward and outward. Pressure over the head was painful. Between the scaphoid and the internal malleolus, in the region normally occupied by the head of the astragalus, a deep depression could be felt. The forefoot was adducted and obviously shortened. From the tip of the right internal malleolus to the great toe, the distance measured eight and one-fourth inches, while in the injured foot, the measurement was only seven and one-half inches.

On March 22, 1928, under general anaesthesia an attempt was made to reduce this dislocation. While the ankle and foot were firmly held by an assistant, the forefoot was strongly plantar-flexed and adducted. Traction was made at right angles to the tibia in the line of the axis of the astragalus and counterpressure was applied against the head of the astragalus, without success. Several efforts having failed, it was decided to apply the reducing force in the direction which was presumed to be that of the force which had



FIG. 2.—Dorso-plantar roentgenogram showing relationship of astragalus after reduction. By actual measurement upon these two roentgenograms the shortening of the internal border of the foot can be seen to be due to the displacement of the head of the astragalus.

produced the injury. Consequently, the foot was plantar-flexed, adducted and inverted, *i.e.*, sharply supinated and plantar-flexed. Thanks to the integrity of the ligaments of the forefoot, the scaphoid followed the direction of the forefoot and slipped from beneath the neck of the astragalus. With a snap that could be heard several feet away, the head of the astragalus slipped into place. Immediately afterward, both active and passive motions appeared to be relatively free and painless in all directions. The depression previously felt behind the scaphoid was now found to be occupied by the replaced head of the astragalus. The distance from the internal malleolus to the tip of the great toe measured eight and one-fourth inches as in the right foot, and X-ray photographs showed that the luxation had been reduced. (Fig. 2.) A plaster-of-Paris bandage case, with the foot in moderate valgus and at right angles to the leg, was applied from the toes to midway up the leg.

At the end of two weeks, preparatory to the beginning of physiotherapy, another X-ray was taken and to my chagrin I discovered that the dislocation had recurred within the case. The patient was therefore again taken to the operating room, and the dislocation again reduced. The foot was this time put up in an extreme flat-foot position with a thick pad making pressure over the head of the astragalus. Repeated roentgenograms showed the maintenance of the reduction, but evidence of a mild arthritis, probably traumatic, at the astragalo-scaphoid joint. At the end of three weeks the case was bivalved and baking and massage begun. Both active and passive motion in all directions

was free and painless. The patient was advised to begin weight-bearing in the case. At the end of a week of such treatment the case was entirely removed and a shoe with an external elevation of one-fourth inch was prescribed. Within three weeks the patient was able to use his foot freely and without discomfort and he was consequently discharged as cured.

Either as a result of inaccuracies or omissions in description of the other tarsal joints, a great deal of misconception and confusion appears to have crept into our current ideas concerning talo-navicular dislocations. Thus the term "subtalus dislocation" has been used to include dislocations occurring at the astragalo-navicular, at the astragalo-calcaneal or in the mid-tarsal joint. "Medio-tarsal dislocation" has been taken to connote true medio-tarsal as well as talo-navicular dislocations, while "astragalo-scaphoid dislocation" has been made to embrace not only dislocations at this joint but also dislocations of the scaphoid alone. To these errors some of our most eminent authors have fallen victim.

Properly speaking, the term "subastragaloid" should be reserved for those cases in which the astragalo-calcaneal as well as one or both of the medio-tarsal ligaments have been torn but in which the tibio-tarsal ligaments have remained intact. In typical instances these cases are characterized by definite röntgenological and clinical manifestations as, for example, the apparent lengthening of the heel. "Medio-tarsal" should be applied only to those cases in which it can be demonstrated that both the calcaneo-cuboid and the astragalo-scaphoid joints have been luxated, while the astragalo-calcaneal and all the other tarsal and metatarsal joints bear their normal relationships to each other. As regards isolated calcaneo-cuboid and astragalo-scaphoid dislocations, both of which have been described as occurring alone, it would seem better terminology to consider each as a separate type rather than as partial medio-tarsal dislocations.

With this idea in mind, Dubrueil suggested for talo-navicular luxations the designation of "preastragaloid". This he further modified by the addition of the words *superior* or *inferior*, to indicate the position of the dislocated anterior part of the foot in relation to the head of the astragalus. Although this term has no especial advantage over the more commonly employed "astragalo-scaphoid," it is at least in consonance with modern usage which considers the distal bone as that which is dislocated upon the proximal. It serves, moreover, to emphasize the difference between this and the more usual type of subastragaloid dislocations.

The only apparent disadvantage in the use of this term is that it seems unduly to stress the significance of the pretalus and thus to postulate a mechanism in the production of this injury. This objection is of greater validity in view of the fact that it is precisely the question of mechanism which is most open to dispute in the discussion of these cases. Chassaignac in his brief treatment of the subject described the tearing of the dorsal astragalo-scaphoid ligaments as a result of supination of the forefoot, and the subsequent dislodgement of the head from its articulation with the

ASTRAGALO-SCAPHOID DISLOCATION

scaphoid as one would squeeze a melon pip between the fingers. Reissman¹² too, in a much more detailed article on subtalus dislocations, thought the head was dislocated in consequence of excessive supination of the forefoot. Morian, on the other hand, maintained that the explanation was to be sought in the concurrence of a supinating and an extending force. However, employing this mechanism experimentally, he was able to reproduce this luxation but once and then only in a young child. Gumbel, more inclined to the acceptance of Morian's than Reissman's theory, felt the necessity of amending it by the addition of a dorsi-flexing force acting only upon the inner half of the foot.

While all of these theories doubtless represent a large part, if not all of the facts, the reader is left with a singular feeling of their incompleteness when the general principle is applied to the explanation of the individual case. The actual displacement of the head of the astragalus seems to be adequately accounted for, yet the fact that the head is at one time found pointing to the dorsum and at other times to the plantar surface of the foot is passed over in a somewhat vague manner. All those who have written on this subject have affirmed the importance of supination or pronation in the mechanism of this injury but none have insisted upon the rôle played by wedge-like action of the head of the astragalus itself. It seems that if, instead of considering the forefoot as the prime factor, the emphasis were placed on the astragalus as the active force, the mechanism here suggested would present a simpler and more consistent explanation of the different forms of talo-navicular dislocation. This can, perhaps, be best appreciated from a review of certain already established facts of the anatomy and physiology of the astragalus.

If a normal foot be examined in the fresh state it will be seen that the astragalus is the only bone in the body which has no muscles attached to it, despite the fact that about it centre the most important motions of the tarsus. In its motion, consequently, it is subject to the forces transmitted to it through its perfectly adapted tibial, calcaneal and scaphoid articulations. In this respect it may almost be considered to function as a sort of meniscus interposed between the leg and the rest of the tarsus. When the foot is flexed or extended, the astragalus acts as a firmly-fixed part of the tarsus, while when the forefoot is supinated or pronated it remains motionless and may be thought of as an integral part of the leg. Apart from this function in mediating the motions of the foot, the astragalus functions to distribute the body weight to the calcaneus and the heads of the first and fifth metatarsal bones, the three points of support of the tarsal tripod.

In the anatomical position, the ligaments forming the astragalo-scaphoid capsule are lax and the head, fairly well covered by the scaphoid, points forward and slightly downward in the plane formed by the tibia and the head of the second metatarsal bone. The body weight is transmitted downward to the upper surface of the astragalus and thence is distributed almost equally to the calcaneus, and the heads of the first and fifth metatarsal bones. When the forefoot is put into supination, the head of the astragalus disengages

from its scaphoid covering and about one-fourth of its surface can be felt projecting against the upper and outer part of the capsule. The neck and head of the astragalus now lie in a plane determined by the tibia and the head of the fifth metatarsal bone. The body weight is resolved into three forces of which the component lying in the plane of action is the greatest, while those distributed to the calcaneus and the head of the first metatarsal are the least. When the foot is pronated, the opposite is true. The inner ligamentous structures are put under tension, since the neck of the astragalus and the tibia establish a plane of action which contains the greatest component of the resolved body weight and which passes far to the inner side of the head of the first metatarsal bone. If in each of these attitudes the foot be placed either in extension or inflexion, it can be seen that the forefoot may be brought into four different positions as regards the head of the astragalus. Depending upon the relative strengths of the four active forces, supinating, pronating, flexing or extending, the forefoot tends to look either downward and outward, downward and inward, upward and outward, or upward and inward. At the extremes of these motions, the diagonally-opposite ligaments are put under tension both by the action of the forefoot and by the impingement of the head of the astragalus.

It is, in my opinion, just at this point that the explanation of talonavicular dislocations is to be sought, for it is just at this point that the upward resistance of the ground, transmitted through tension of the capsular ligaments, opposes the downward force of the body weight transmitted through the head of the astragalus. In the case here reported, for example, the following sequence of events may be predicated. As the body of the patient struck the ground on his supinated and plantar-flexed foot, the fall was checked by the resistance of the ground against the foot. Under the influence of this counter-resistance, the forefoot turned more and more into supination and plantar-flexion until the limit set by the length of the astragalo-scaphoid ligaments and the interposition of the soft parts was reached. At this moment the head of the astragalus, continuing to act downward in the axis of fall, was driven like a battering ram against the tense upper and outer parts of the capsule. Being already about half-disengaged, the head of the astragalus slid completely beyond its articulation with the scaphoid and, tearing through the capsular ligaments, came to lie upon the upper surface of the cuboid.

Had the forefoot been in dorsiflexion at the moment of impact, the direction of the force would have been against the outer and lower part of the capsule, and the head would in all likelihood have been displaced outward and downward, and the cuboid would have been found resting on the upper surface of the neck of the astragalus, as in the cases reported by Wodarz, Dubrueil and Chassaignac. On the other hand, if the foot had been in pronation instead of in supination, the dislocation of the head would have been inward and upward, as in the case reported by Winter. The majority of cases reported have been those in which the forefoot was injured in the attitude of

ASTRAGALO-SCAPHOID DISLOCATION

supination and plantar-flexion, and the head of the astragalus consequently pointed upward and outward. Next in frequency were those in which the head pointed downward and outward, while the most unusual were those in which the foot was in pronation at the time of injury. This was to be expected from the knowledge that, when hanging freely under the influence of gravity, the forefoot tends normally to assume a position of supination and plantar-flexion. Though, like the other authors on this subject, I have been unable to verify this hypothetical mechanism by the actual experimental reproduction of this dislocation, it seems, better than the theories previously offered, to account not only for the integrity of the calcaneo-cuboid and astragaloid ligaments, but also for the variations which have been noted in the displacement of the head of the astragalus.

Clinically, astragalo-scaphoid dislocations present certain well-defined characteristics which should at least suggest if not definitely establish the diagnosis. There is usually a history of a severe wrenching of the foot following a fall from a moderate height. The foot is found moderately swollen and held either in a fixed varus or valgus. The head of the astragalus is tender and is usually to be felt beneath the skin in its dislocated position, while at its normal site behind the scaphoid there is a deep depression. The inner border of the foot, measured from the internal malleolus to the tip of the great toe, is shorter than on the unaffected side, while the distance from the inner malleolus to the tip of the calcaneus remains unchanged. By measuring and comparing the röntgenograms of both feet it can be seen that this variation is due solely to the displacement of the head of the astragalus. And finally, the stereoröntgenogram is absolutely diagnostic. Without its aid, the differentiation between talo-navicular and medio-tarsal dislocation would be well-nigh impossible. With it the recognition of tibio-tarsal, subtarsal, medio-tarsal or scaphoid dislocations becomes a relatively simple matter.

The treatment of course consists in reduction at the earliest possible moment. In the early cases this has usually been easily accomplished. Certain hindrances to reduction have, however, been observed. Thus, after several failures at closed reduction, Goebel found, at operation, that the obstruction in his case was the tendon of the tibialis anticus muscle. Others have found that the interposition of the frayed-out capsular ligaments has prevented reduction. In such cases, as well as in those treated after the lapse of some time, recourse must be had to open operation. Simple reduction with suture of the torn ligaments, astragalectomy and even scaphoidectomy have been attempted with varying degrees of success. On the other hand, in instances where reduction was impossible and the patients refused operative intervention, moderately good function of the foot was obtained without treatment (Rais, von Winiwater). In the case here presented the difficulty was found not in the reposition but in the maintenance of the reduction. Following the first effort, when the dislocation recurred within the case, an attempt was made to prevent relaxation by bringing counterpressure to bear against the head of the astragalus. Had this been unsuccessful, it was felt that operation,

HENRY MILCH

either Hoke's subastragaloid arthrodesis or an arthrodesis of the astragalo-scaphoid joint, would have been justified. Fortunately, the satisfactory outcome precluded resort to this rather unpleasant necessity.

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ASTRAGALECTOMY FOR FRACTURES OF THE ASTRAGALUS

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AT BEST, the operation of astragalectomy is mutilating. The removal of the astragalus, which is the keystone of the bony arch of the foot, the substitution of a new joint for the ankle, the widening of the mortise between the malleoli by removal of some of the articular cartilage from both, as is frequently necessary—these steps must result in what is far from a normal foot.

Yet the operation, wisely used, is of much benefit. Originated by Whitman as a procedure for the aid of paralytic calcaneus and calcaneo-valgus deformities, it fell later into some disrepute because of its application by other less experienced surgeons to virtually all deformities of the foot. The consensus of opinion of orthopaedic surgeons today seems to be that astragalectomy is an efficient operation for those deformities for which Whitman devised it, but that for varus and valgus positions of the foot, the sub-astragaloid arthrodesis is preferable.

At various times, more often in the first few years following Whitman's description of astragalectomy than recently, removal of the astragalus has been practiced for fracture of that bone. Most recent writers have mentioned this procedure only to condemn it. Cotton¹ says, "It is hard to find any justification for the astragalectomies still occasionally performed in these cases". Scudder² advises the removal of a fragment of the astragalus when it cannot be accurately reduced, but does not advise removal of the entire astragalus, except in compound fractures. Wilson and Cochrane³ state that operative intervention may be indicated in comminuted fractures of the body of the astragalus, but as a late procedure. They do not mention astragalectomy. A search of the American literature since 1916 on fractures of the astragalus reveals little sympathy for astragalectomy as a method of treatment. Kellogg Speed⁴ is an exception, saying, "If the bone is broken horizontally or severely comminuted, or part is driven down into the calcaneum, it should be completely removed by open operation at once".

This condemnation is natural. No surgeon wants to do an amputation; nor does one like to remove from the foot one of its most important bones. Yet we believe that in a certain number of cases of fracture of the astragalus there is no alternative to an astragalectomy. It is better to have the "rocker motion" of the foot on the leg, which follows astragalectomy, than to have the stiff and painful ankle which often precedes it.

We have recently looked over our records to ascertain the number of astragalectomies done for fractured astragalus since 1919. Ten patients have had the operation for this cause. Probably there were a few others

on whom office records were faulty or not kept. But it is likely that this is within two or three of the total number of cases in which we have done this operation for fracture of the astragalus in the past nine years. It was thought to be of interest to review these cases, to consider the indications for removal of the bone, and to learn the ultimate result from the operation.

Fracture of the astragalus, while not common, is not unusual enough to deserve the brief discussion that most text-books devote to the subject. Certainly, when inefficiently treated or when overlooked, as one of our cases was, it is a very disabling injury. There are some simple linear fractures of the astragalus, without displacement, complained of as "sprained ankle" by the sufferer, and evident only by use of the X-ray, which are easy to cure by external fixation and massage. These are often overlooked, and the result is merely static trouble of the foot. But most fractures of the astragalus are due to severe trauma and are not simple. There is often severe comminution and crushing of the body, or the less crippling fracture of the neck with displacement of the head. These injuries, unless expertly treated, leave deformity and disability in their wake, and even when under the care of an excellent surgeon often demand operation.

Previous Treatment and Time of Astragalectomy.—Of the ten cases here discussed, only three were seen within a month of the injury. On one of these, seen ten days after injury, closed reduction of the comminuted bone was attempted without success. In another, seen four weeks after injury, another surgeon had unsuccessfully attempted open reduction of a transverse fracture through the body. On the third, seen three weeks after injury, two attempts at closed reduction elsewhere had been unsuccessful, and the foot was in no condition for open operation for nearly four weeks more because of the soft tissue trauma. The other cases were operated on two, four, eight, nine, and ten months, and six and fifteen years, respectively, after the fracture had been sustained. Of these seven cases only four had had any treatment, this consisting of a plaster case applied presumably after attempted reduction. One had not seen a physician for five months after the injury and one had been wrongly diagnosed as a fracture of the external malleolus and treated with an adhesive strapping support for the ankle.

Type of Fracture.—Of the ten cases, eight were severe fractures of the body of the astragalus. Six were comminuted, one a compound, comminuted fracture, with a large fragment displaced inward and downward and lying to the inner side of the os calcis, while the eighth was a transverse fracture through the body, with displacement. In one of the remaining cases the fracture line was through the neck; in the other, operated upon fifteen years after injury, there had apparently been a fracture through the posterior margin of the trochlear surface, complicated by a fracture of the internal malleolus. It is interesting to observe that in three patients the condition found at operation was much more serious than the Röntgen-ray appearance led us to expect. In one of these, the röntgenologist reported a vertical fracture through the centre of the trochlea, while at operation, in addition to this,

ASTRAGALECTOMY FOR FRACTURES

were found a fracture through the head and another through the body just above the inferior surface. In two other cases the comminution found at operation was much more severe than that seen in the X-ray films. This difference is probably due to the difficulty of obtaining a perfectly clear picture of a bone, part of which is wedged in between two other bones.

Indications for Operation.—The indications for operation were pain, deformity, and disability. One case was compound, with the larger portion of the astragalus completely out of the joint, and the indication for removal here was perfectly clear. Six others had suffered for periods ranging from three and one-half months to fifteen years. All of these had pain on weight bearing and two could walk only with crutches. Two showed varus deformity, one eversion and abduction, and another plantar flexion and eversion. One patient was unable to get the heel to the floor without abducting and externally rotating the entire extremity. There is no note as to the deformity of the sixth. All had very marked limitation of motion in the ankle-joint. One patient showed 50 per cent. normal dorsiflexion and plantar flexion, while the others are noted as having very slight, if any, motion in the ankle. The indications in these seven patients for astragalectomy seemed clear. There was practically complete disability of the affected extremity in all, whereas in a non-paralytic case after astragalectomy it is the usual custom of the Industrial Commission in this state to allow 25 per cent. permanent disability of the extremity.

The remaining cases were recent fractures. One, seen three weeks after injury, had such severe crushing of the astragalus that a completely ankylosed ankle seemed certain unless the fragments were excised. Another had severe comminution and displacement. The third showed a transverse fracture of the body in which reduction, though effected by open operation, could not be maintained. It was felt that the disability resultant from non-union or from union in malposition would be greater than that from astragalectomy.

Operation.—The operation performed was the astragalectomy of Whitman, which will not be described. After-treatment consisted in a plaster case from above the knee to the toes for six weeks, followed by a short caliper brace which was worn for six to eight months longer. Walking was encouraged as soon after the application of the brace as swelling and pain permitted.

Results.—After removal of the astragalus, the foot is necessarily so far from normal that, *ipso facto*, an unusually good result could hardly be called excellent. Those feet in which there are fifteen to twenty degrees motion at the ankle, which are stable, which are painless or only slightly sore after a day's work, and in which there is complete lateral alignment under weight bearing, are called good results. Those in which there are good stability and motion, but in which either pain or deformity or both persist, though not enough to interfere with walking, are called fair. Loss of motion or stability, pain or deformity sufficient to interfere with walking—any one of these denotes a poor result.

GRAHAM AND FAULKNER

Of the ten patients operated upon, nine have been followed up. Five of these were re-examined by one of the writers; two, nine months after operation; two, one year afterward, and one, two years afterward. Four others were written follow-up letters inquiring into motion, stability, deformity, pain, and function. Only one case could not be traced.

The results in five cases were good, with a painless, functioning foot and a return to their former work. Two of the best results were in cases operated upon within four weeks of the injury—one a badly comminuted fracture, the other a transverse fracture through the body which could not be held in position after open reduction.

In two patients the results were fair. Both of these were much improved, but one reported that he could not do work which required long periods of weight bearing by the foot, because of pain; while the other reported that his foot "rolled out" under his leg and that he could not do the same work on the farm as before his injury.

The other two cases are definitely poor results. A poor result was expected in one of these, as there was present a compound, infected fracture of two months' duration. He now has a painless foot, ankylosed in about ten degrees equinus, which is healed and on which he walks very well. On the whole, this might be called a fair result, considering his condition when first seen. In the other poor result, hypertrophic arthritis has caused bony ankylosis, with the foot in moderate equinus and some pain on weight bearing. This woman had a fracture of six years' duration, with much new bone formation about both malleoli. After removal of the astragalus, the arthritic condition continued, to result finally in ankylosis of the new joint.

CONCLUSIONS

1. Fractures of the astragalus rank with fractures of the os calcis in resultant disability.
2. As the best result from removal of the astragalus is usually rated as giving about 25 per cent. disability in the extremity, open reduction should be resorted to in more instances, thereby eliminating many late astragalectomies.
3. If the reduction obtained by open operation cannot be maintained, or, if the comminution and crushing of the bone is very severe, early astragalectomy is indicated.
4. In late cases of mal-union and of non-union, astragalectomy is the treatment of choice.

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ACUTE FRACTURE-DISLOCATIONS ABOUT THE ANKLE-JOINT

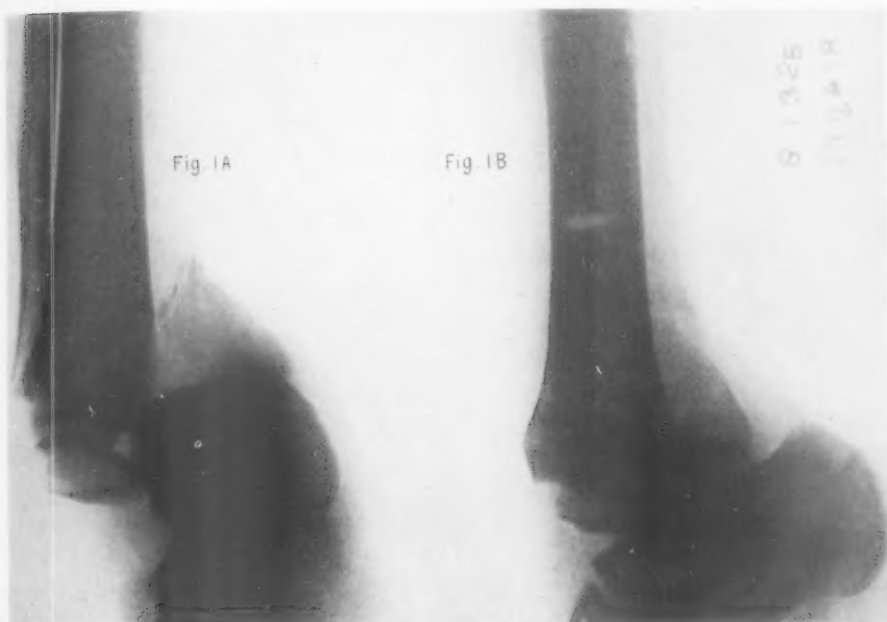
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SURGICAL literature contains ample discussion and information upon the types and the treatment of fractures and dislocations about the ankle-joint.

It is, obviously, needless to duplicate or even summarize that which has



FIGS. 1A and 1B.—Case I, W. B. Showing Compound Fracture-Dislocation of Right Ankle with a bi-malleolar Fracture.

already been so ably presented. It is my desire, however, to present some of the specific complications which are frequently encountered in acute severe fracture-dislocations of the ankle-joint but which are not often emphasized.

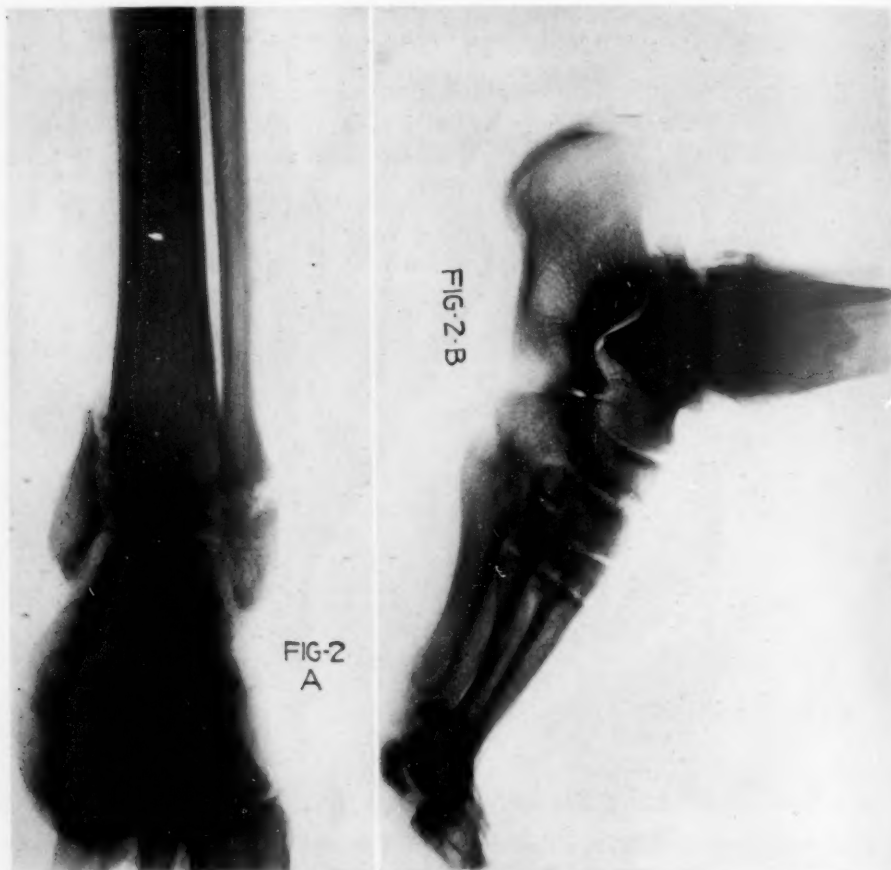
Five cases have been selected from a large series of severe fracture-dislocations about the ankle-joint. Rather detailed descriptions of the cases are being presented because they present the most common complications that are encountered in such type of injury.

There is no doubt but that the frequency of such type of injury is on the increase. This is due to the increased use of motor driven vehicles, as well as to increased speed of locomotion. It is interesting to note that

three out of the five cases described were injuries incident to the use of the automobile.

The cases and their detailed histories are as follows:

CASE I.—W. B., colored male, steel worker, aged thirty-five years. Admitted to the Orthopaedic Service, Employees' Hospital, Fairfield, Ala., August 13, 1925. Patient reported having had a heavy weight fall across feet and legs a few moments previous



FIGS. 2A and 2B.—Case I, W. B. Showing good union and good position of Compound Fracture-Dislocation of Right Ankle.

to admission to the hospital. Examination showed a severe jagged compound wound and fracture-dislocation of the *right* ankle-joint, the wound being on the external surface of the ankle, with the lower end of the tibia and external malleolus protruding.

Further examination showed practically a traumatic amputation of the *left* leg through the middle third. Röntgen-ray examination (Figs. 1A and 1B) of the right ankle showed a bi-malleolar fracture with marked displacement and a backward and inward dislocation of the astragalus at the tibial articulation.

Ether anæsthetic was given immediately and the right ankle, foot and the lower half of the leg cleansed thoroughly with soap and water and then large quantities of ether used. The protruding ends of the tibia and the external malleolus were cleansed with Dakin's solution and reduction was immediately accomplished without difficulty.

FRACTURE-DISLOCATIONS ABOUT THE ANKLE-JOINT

The compound wound was debrided and closed with deep interrupted chromic catgut sutures and the skin was closed with interrupted silkworm sutures. The foot was placed at right angle to the leg at the ankle-joint, midway between adduction and abduction. Due to the severe injury to the soft structures it was with great difficulty that this position was maintained until a plaster case was applied.

A large amount of circular padding with sheet cotton was applied from the base of the toes to the middle of the thigh, with proper protection of the wound with sterile



FIGS. 3A and 3B.—Case I, W. B. Showing perfect functional results of Compound Fracture-Dislocation of Right Ankle.

dressings. A circular plaster bandage was then applied with about 20° flexion at the knee-joint. Amputation was done through the middle third of the left leg.

Following the operation on the right leg very close attention was paid to the circulation. At no time, however, did we feel very uneasy about the circulation, because sufficient padding had been used.

Röntgen-ray examination, following operation, showed good position of the fractures. Twenty-four hours following operation a window was cut over the compound wound. The patient had a post-operative elevation of temperature within thirty-six hours to 101° F., which became normal five days following operation. Except for a slight serous drainage from the wound the patient had no infection. The case remained in place for five weeks when the anterior half was removed.

Daily active and passive motion was then carried out with application of local heat

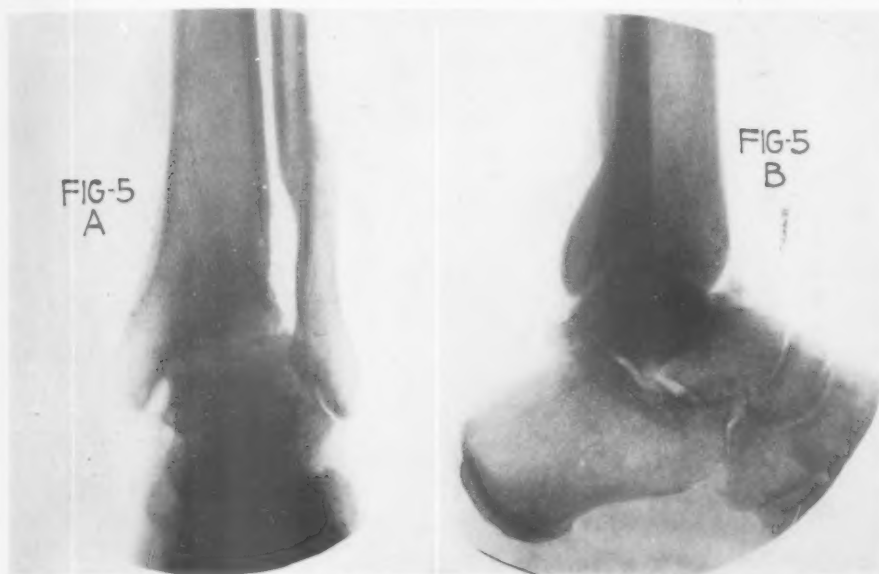


FIGS. 4A and 4B.—Case II, L. J. Showing Compound Fracture-Dislocation of Right Ankle.

FRACTURE-DISLOCATIONS ABOUT THE ANKLE-JOINT

to the foot and the leg. The posterior half of the case was removed in seven weeks from date of the injury and weight bearing was commenced nine weeks following reduction. Gradual improvement was noted and within four months following injury a röntgenogram showed good union and good position. (Figs. 2A and 2B.) Physical examination of the ankle at that time also showed good functional results. (Figs. 3A and 3B.) An orthopædic heel, with elevation of a quarter of an inch on inner half of heel, supplemented with a felt pad to instep, was added to right shoe when weight bearing was first commenced.

CASE II.—L. J., white male, age forty-six years. Admitted to hospital November 7, 1925, with a history of having been in an automobile accident a short time previous. Examination showed a compound fracture and a dislocation of the right ankle, with the compound wound on the inner surface of the ankle, and the lower end of the tibia protruding through the wound. The foot was very cold and had no circulation whatever.



FIGS. 5A and 5B.—Case II, L. J. Showing good union and fair position of Compound Fracture-Dislocation of Right Ankle.

Röntgen-rays (Figs. 4A and 4B) showed a fracture of the lower third of the right fibula, with considerable overlapping, and also a fracture with marked displacement of the internal malleolus, with an external and a posterior dislocation of the astragalus at the tibial articulation. The compound wound was very dirty and the edges were badly torn. Nitrous oxide-oxygen anaesthetic was given and the operative technic was carried out as in Case I. The post-operative care also was the same as in Case I. The patient was discharged from the hospital December 5, 1925, with case still on leg, but with no drainage from the compound wound.

This patient was observed, at frequent intervals, in the Orthopædic Out-Clinic Department until entirely recovered. The anterior half of the plaster case was removed five weeks after injury and baking with active and passive motion commenced. The posterior half of the case was removed eight weeks following injury.

In this patient the compound wound broke down partially and was very prolonged in healing, due entirely to the severe compound wound into the ankle-joint, and also to the fact that it was a street accident, in the author's opinion, thereby having been subjected to greater contamination. The wound did not heal entirely until ten weeks

H. EARLE CONWELL

following injury, due to a low grade osteomyelitis. At no time, however, was the sluggishness of the healing process of the wound considered serious. It, however, was extremely annoying.

This patient had considerable pain on moderate motion which, following removal of case, was relieved, to a certain extent, with tri-daily applications of dry and moist heat.

Nine weeks following injury the patient was allowed to commence weight bearing,



FIGS. 6A and 6B.—Case II, L. J. Showing functional results of Compound Fracture-Dislocation of Right Ankle.

at which time he had moderate motion in the ankle-joint, with some instability and considerable pain. By a continuation of the heat and the hot baths the pain in the ankle was considerably relieved. The patient gradually developed a complete ankylosis in the ankle, and not until this occurred was the pain entirely relieved, or full stability of the ankle obtained.

This patient was not able to return to work until six months following injury, at which time, however, he had good union with fair position of ankle-joint. (Figs. 5A and 5B.) Physical examination (Figs. 6A and 6B) showed a practically ankylosed but painless ankle. The patient returned to the same type of work which he was doing at the time of injury.

CASE III.—J. H., colored male, miner, age thirty-five years. Admitted to the hospital June 24, 1926, with a history of having had a large rock fall on his legs and feet. The left leg showed a severe compound comminuted fracture of the middle third of the tibia and fibula, or practically a traumatic amputation. The right leg showed a simple fracture-dislocation of the ankle, with marked deformity and intraarticular hæmorrhage.

FRACTURE-DISLOCATIONS ABOUT THE ANKLE-JOINT



Figs. 7A and 7B.—Case III, J. H. Showing Simple Fracture-Dislocation of Right Ankle.

Röntgen-rays (Figs. 7A and 7B) showed a fracture-dislocation. The astragalus was dislocated posteriorly, with a fracture of the inferior articular surface of the tibia, posterior edge.

Ether anæsthetic was given immediately and reduction of the simple fracture-dislocation was accomplished without any difficulty. The foot was placed at a right angle to the leg, midway between adduction and abduction and—after padding the foot, leg and the thigh well—a circular plaster bandage was applied from the base of the toes to the middle of the thigh, with 20° of flexion at the knee-joint. Amputation of the middle third of left leg was carried out at the same time.

On account of the maximum amount of swelling and pressure about the ankle-joint, due to a very marked intramuscular and subcutaneous hæmorrhage, the anterior half of the plaster case was bi-valved along its entire course.

In this type of injury it has been considered best to bi-valve the case to prevent a



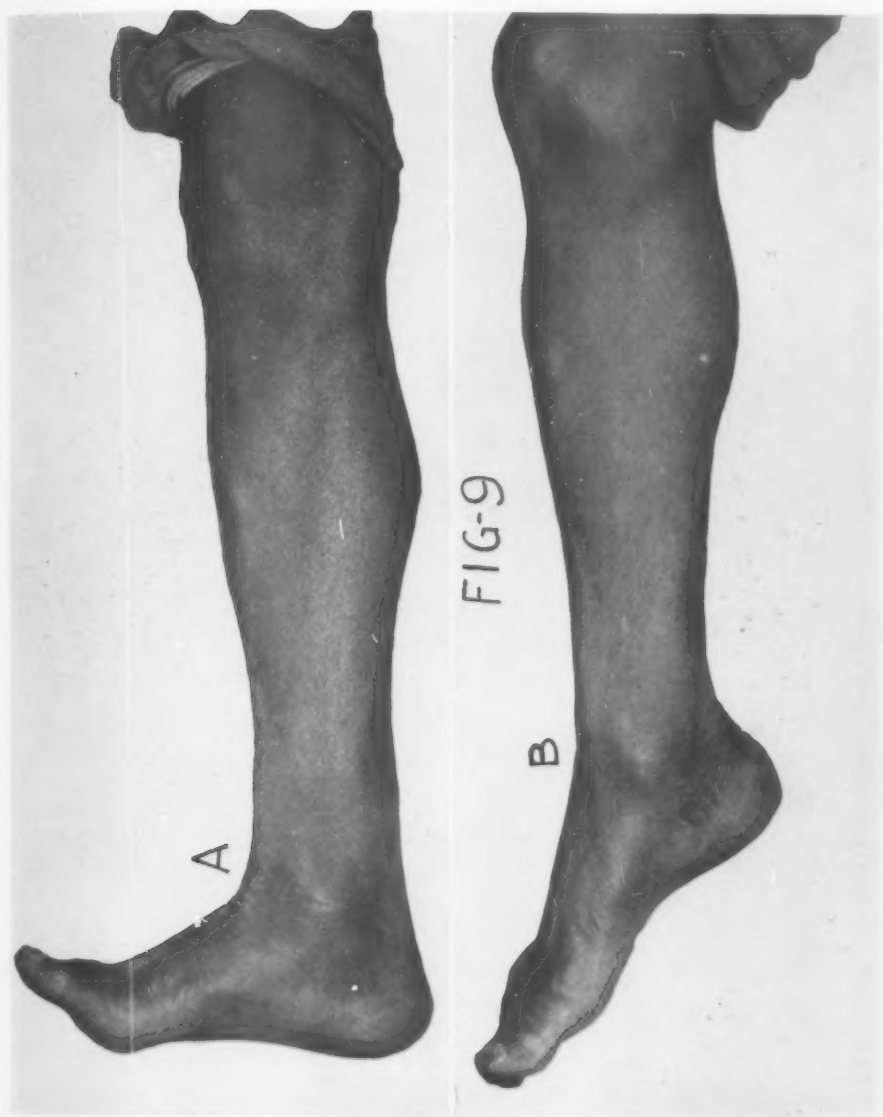
FIGS. 8A and 8B.—Case III, J. H. Showing good union and good position of Simple Fracture-Dislocation of Right Ankle.

further obstruction of the circulation to the ankle and the foot. This is more liable to happen in the simple than in the compound fracture, because drainage takes place in the latter. The bi-valved case was left in place for three weeks when anterior half was removed. Baking with active and passive motion to the ankle-joint and leg was carried out daily thereafter. The patient was discharged July 22, 1926, and frequent observation was carried out in the Orthopædic Out-Clinic Department following discharge.

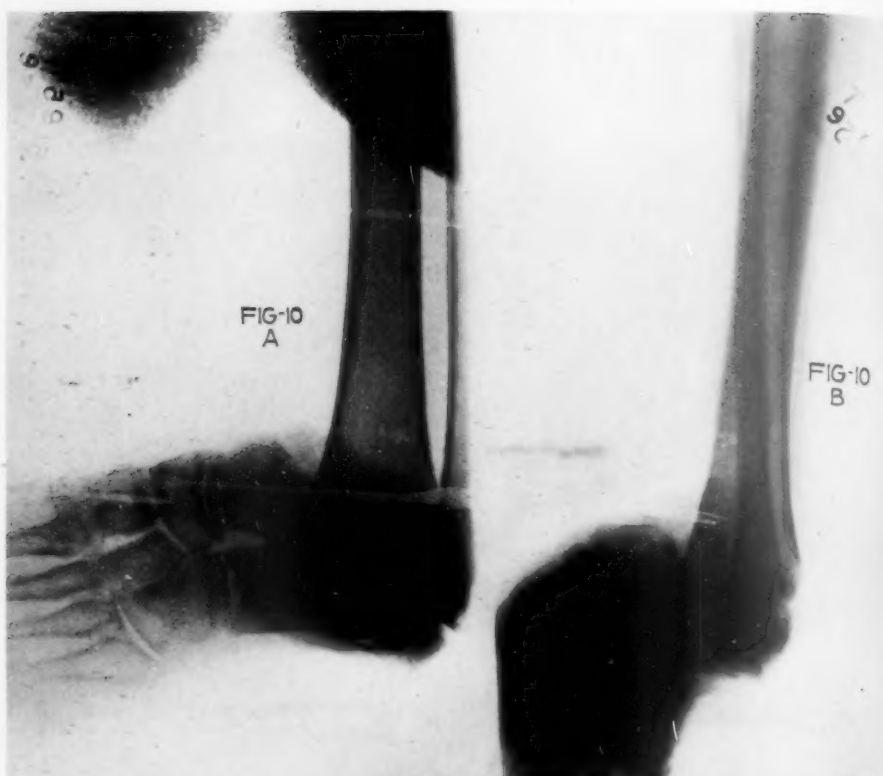
The posterior half of the case was removed five weeks following injury and hot baths and olive oil massage were commenced. After applying an orthopædic heel and a felt pad to the instep of the right shoe, weight bearing was commenced eight weeks following injury and patient returned to his former occupation three weeks later. Röntgen-rays (Figs. 8A and 8B) showed good union and good position of the fracture-dislocation and physical examination (Figs. 9A and 9B) showed perfect functional results.

CASE IV.—S. R., white male, age thirty-one years. Admitted to the hospital August 22, 1926, with a history of having been injured in an automobile accident a few moments previous. Examination showed a severe compound fracture-dislocation of the left ankle, with the compound wound over the external lateral surface of the left ankle. The lower ends of the tibia and fibula were protruding through the wound.

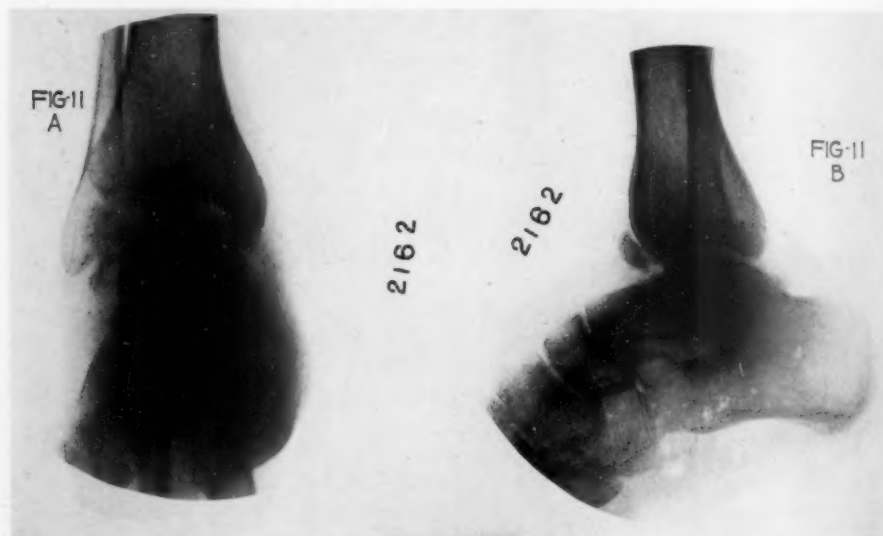
FRACTURE-DISLOCATIONS ABOUT THE ANKLE-JOINT



FIGS. 9A and 9B.—Case III, J. H. Showing perfect functional results of Simple Fracture-Dislocation of Right Ankle.



FIGS. 10A and 10B.—Case IV, S. R. Showing Compound Fracture-Dislocation of Left Ankle.



FIGS. 11A and 11B.—Case IV, S. R. Showing good union and position of Compound Fracture-Dislocation of Left Ankle.

FRACTURE-DISLOCATIONS ABOUT THE ANKLE-JOINT

Röntgen-rays showed (Figs. 10A and 10B) a fracture-dislocation of the left ankle, with a chip fracture at the lower articular end of the tibia, anterior surface, and a fracture through the body of the astragalus, part of which was protruding through the compound wound. Further physical examination showed the foot was at a right angle to the inner lower surface of the tibia. There was absolutely no circulation whatever in

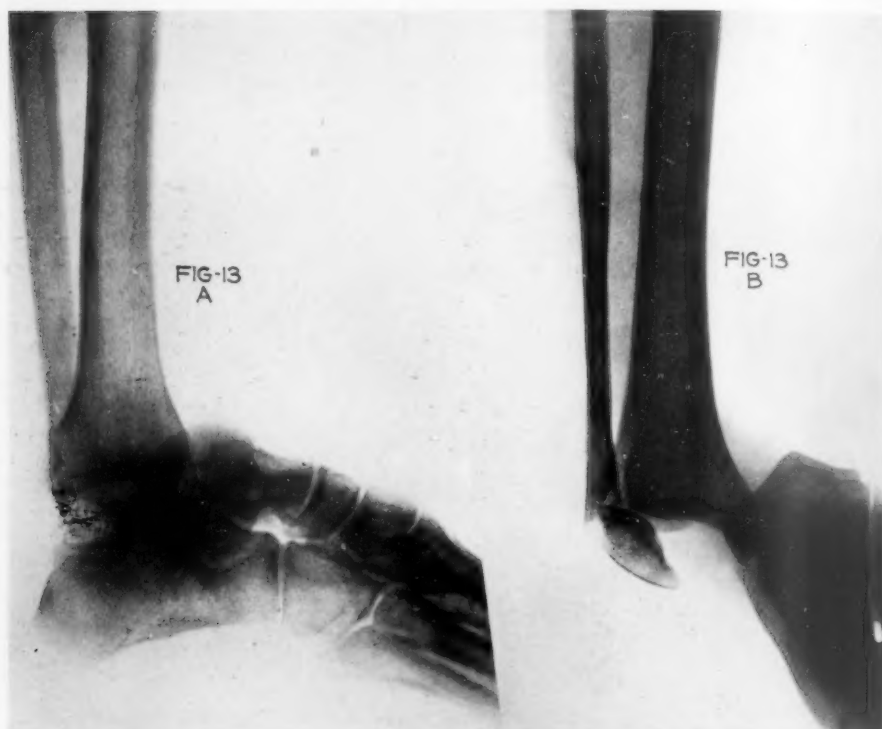


FIGS. 12A and 12B.—Case IV, S. R. Showing functional results of Compound Fracture-Dislocation of Left Ankle.

the foot. Nitrous oxide-oxygen anæsthetic was given and reduction made immediately. The operative treatment was carried out as in Case I.

Following the application of the plaster case a window was made in the plaster over the compound wound. The patient had slight drainage from wound, more of a serous type, for ten or twelve days. Other than this he had an uneventful post-operative recovery. He was discharged from the hospital September 24, 1926.

The anterior half of the case was removed in six weeks following injury and active and passive motion carried on daily. The posterior half of the case was removed the



FIGS. 13A and 13B.—Case V, W. S. Showing a Simple Fracture-Dislocation of Left Ankle.



FIGS. 14A and 14B.—Case V, W. S. Showing good union and position of Simple Fracture-Dislocation of Left Ankle.

FRACTURE-DISLOCATIONS ABOUT THE ANKLE-JOINT

ninth week. Weight bearing, with the aid of crutches, was commenced within ten weeks from date of injury. This patient had considerable pain and tenderness, with instability in the ankle-joint, for four or five months following injury, and not until he developed an ankylosis did all the pain subside, and the instability of the ankle disappear.

Röntgen-rays finally showed good union and good position. (Figs. 11A and 11B.) Physical examination (Figs. 12A and 12B) showed patient had absolutely no pain, some forward flexion and extension of the front part of the foot. He was able to walk



FIGS. 15A and 15B.—Case V, W. S. Showing perfect functional results of Simple Fracture-Dislocation of Left Ankle.

without pain and stated that he was comfortable and doing the work which he was doing at time of injury without difficulty.

If conservative treatment had not been carried out in this case amputation probably would have been necessary. A further economic complication in this case was that this man had suffered amputation of his right arm several years previous.

CASE V.—W. S., white male, age twenty-three years. Admitted to the hospital August 29, 1926, with a history of having been in an automobile accident only a few moments previous. Examination showed a simple fracture-dislocation of left ankle, with marked swelling and deformity. Röntgen-rays (Figs. 13A and 13B) showed a fracture-dislocation of left ankle, consisting of a fracture of lower end of the fibula, with a forward

and inward dislocation of the astragalus at the ankle-joint. Nitrous oxide-oxygen anæsthetic was given and reduction was accomplished without difficulty. The treatment was carried out as in Case III—that is, the circular plaster case was bi-valved all along the course of its application and close observation was made of circulation. The patient was discharged from the hospital September 7, 1926. Frequent observation was carried out in Orthopædic Out-Clinic Department thereafter.

The anterior half of the plaster case was removed in four weeks and active and passive motion commenced, with application of heat to ankle, leg and foot. The posterior half of the case was removed in six weeks and weight bearing was commenced eight weeks following injury. An orthopædic heel was applied. This was raised on inner half one-fourth inch and a felt pad was applied to the instep of shoe, when weight bearing was first commenced. Final Röntgen-rays showed good union and good position. (Figs. 14A and 14B.) Final physical examination showed perfect function and no disability whatever. (Figs. 15A and 15B.)

CONCLUSIONS

1. Early attention to all fracture-dislocations of the ankle-joint is important. The earlier the reduction and treatment the shorter the period of convalescence.
2. Thorough mechanical cleansing of all compound wounds and the removal of all foreign material is very important. The use of ether-Dakin technic, in the author's cases, was effective.
3. Conservative treatment should always be carried out before amputation is attempted.
4. In every case soft structures, that is, ligaments, tendons, muscles, and blood and nerve supplies should be given careful attention.
5. Considerable difficulty is usually encountered in maintaining proper position of the foot in relation to the leg at the ankle-joint in fracture-dislocations of the ankle, and fixation in an encircling plaster bandage is the only efficient method whereby this can be obtained.
6. Too early motion in some cases of injury to the ankle-joint is not to be desired. Fixation in a plaster case, over a considerable period of time, to aid repair of the soft structures and to prevent instability of the joint, is very important.
7. Complete ankylosis in certain cases is to be desired more than a painful and unstable ankle-joint.
8. The circulation should be watched at all times, especially in the simple fracture-dislocations where extensive subcutaneous and intramuscular hæmorrhage takes place causing severe pressure.
9. To prevent any possible rotation of the tibia and fibula at the ankle, the plaster case must extend from the base of the toes to the middle of thigh. The foot should usually be placed at right angle to leg, midway between adduction and abduction, with twenty to thirty degrees of flexion at the knee-joint.
10. No weight bearing should be carried out before two months in any fracture-dislocation of the ankle, and an orthopædic heel, with proper elevation to inner half as well as felt pad to instep of the shoe, should always be applied.

FRACTURE-DISLOCATIONS ABOUT THE ANKLE-JOINT

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TRANSACTIONS

OF THE

NEW YORK SURGICAL SOCIETY

STATED MEETING HELD NOVEMBER 14, 1928

The President, DR. FRANK S. MATHEWS, in the Chair

DISRUPTION OF SYMPHYSIS-RUPTURE OF THE PERINEUM

DR. CLAY RAY MURRAY presented a little girl, who was admitted to his service at the Lincoln Hospital June 16, 1925. At that time she was three years of age. She had been struck by an automobile, and on admission was in severe shock, unable to walk, and bleeding from the perineum, both ischio-rectal fossæ, and the rectum. Examination revealed a complete laceration of the perineum, and a disruption of the symphysis with a two-and-a-half inch separation of the fragments. The two sides of the pelvis were freely movable, the left side lying at a higher level than the right.

She was sent to the operating room, and 400 cubic centimetres of blood were transfused by the Lindemann method. The perineum lay torn widely open. The rectum lay as a loose tube in the wound, but was not itself torn. The vagina and urethra were in similar condition. The central point of the perineum was completely lacerated. The bladder could be seen in the depths of the wound, having no support. The mucosa of the vulva was widely lacerated, requiring extensive suturing to restore it to relatively normal condition. As a preliminary, catheters were placed in the urethra and vagina to obviate operative trauma to these two organs. Sutures were then passed through what should have been the torn ends of the sphincteric muscles of the rectum, and they were united in the region which should have been the central point of the perineum. Similarly, what was left of the lacerated levator ani muscles was sutured. The torn tissues about the base of the bladder were united, and the wounds in the vulva closed, the labia having been torn from their connection with the vagina. Rubber dam drainage was inserted into the lower angle of the wound, and the space of Retzius, which had been widely opened up by the original trauma, was similarly drained.

The patient reacted well post-operatively, but there was no bladder or rectal control. On the nineteenth she had a sharp collapse following the administration of 100 cubic centimetres of 5 per cent. glucose intravenously, from which she rallied rapidly. On the twentieth she was given a transfusion of 200 cubic centimetres of blood by the Lindemann method, with considerable improvement in her condition. July three a plaster spica was applied to the pelvis, including both thighs down to the knees, after the pelvis had been forcibly compressed laterally in an attempt to overcome the wide separation at the symphysis. She was discharged from the hospital August sixteen, wearing the plaster spica, but still without rectal or bladder control.

Following discharge the bladder and rectal condition gradually improved until in about six months she had regained complete control of these organs. But the wide separation of the symphysis persisted with apparent shortening of one and a half inches in the left leg due to the raising of the left side of the pelvis, resulting in a limping gait, and a waddling one, with pain. After

DISRUPTION OF SYMPHYSIS-RUPTURE OF THE PERINEUM

two years of wearing a tight pelvic girdle without benefit she was readmitted to the hospital for repair of the symphysis. After exposure at operation the attempt was made to pull the two sides of the pelvis together with heavy kangaroo tendon sutures aided by lateral compression of the pelvis by an assistant. It did not seem to be sufficiently effective, and a double strand of heavy annealed wire was substituted for the kangaroo and the two bones were approximated to within three-eighths of an inch of one another. Since that time the apparent shortening of the left leg has disappeared, and the patient's gait has become normal, and she plays about with the other children without disability.

Recently the child began to complain of pain on attempted urination, becoming steadily more severe. The urine was negative. An X-ray showed that the original wire suture was now in three pieces, one piece apparently embedded in each side of the symphysis, and a central piece lying behind and below the symphysis. It was suspected that the central piece was responsible for the bladder symptoms, and on operation for the removal of the wire this fragment was found to be imbedded by one end in the bladder wall, though apparently not actually perforating it. On removal of the wire fragments the patient's bladder symptoms disappeared. She seems now perfectly well and normal.

Recent physical examination shows an apparently good rectal sphincter, but a perineum which is practically nothing but scar tissue, a vagina which presents open, the labia being contracted laterally and there being no evidence of a hymen, and an introitus which is a rigid scar tissue ring. This may have considerable bearing on future marital relations and on child bearing.

DR. WALTER M. BRICKNER showed röntgenograms from a case of traumatic disruption of the symphysis pubis, which also occurred in a little girl thrown down by an automobile, but unlike Doctor Murray's case without injury to any viscus and without any sign of soft part injury. This child had been sent to Doctor Brickner in a temporary splint for the treatment of a fracture of the mid-shaft of the left femur, but examination made him suspect that there was also some fracture in the pelvis. Röntgenograms showed a line of incomplete fracture in the ischium, and a separation of about two centimetres at the symphysis pubis, the right pubic bone being carried away that distance from the mid-line. In any case of separation of the symphysis pubis there must also be a second break in the pelvic ring. It must have been so in Doctor Murray's case although he made no mention of it. This second break may be, *e.g.*, a fracture of the Malgaigne type, or a separation in one of the sacro-iliac joints. In Doctor Brickner's case röntgenograms showed a distinct separation in the left sacro-iliac joint. Under manipulation in anaesthesia the joint separation was reduced with an audible click and the pubes could be felt brought into normal apposition in the mid-line where previously the separation was palpable with the finger tip. Reduction was maintained by adhesive plaster, and by plaster of Paris, involving also the injured lower extremity. The subsequent röntgenograms exhibited show an apparently normal pelvis and very good union of the femur. The child exhibits no limp and is free from all symptoms. At no time was there any urinary disturbance.

OLD FRACTURE-DISLOCATION OF THE ELBOW

DOCTOR MURRAY presented a man, thirty-nine years of age, who was admitted to the Fracture Service of the Presbyterian Hospital, July 10, 1928. Discharged July 28, 1928. He gave a history of having stumbled and fallen one year previously, cutting the left elbow. Did not consult a doctor, and the cut healed in about three weeks. The elbow was sore for only a short time, but he was never able to use it as before the accident. About four months ago he noticed the arm muscles above the elbow becoming smaller, and about three months ago his elbow began to get so stiff that he could no longer get his hand to his mouth. Three days ago, with no other trauma than his work of driving a car, he began to have pain down the front and back of the arm.

Except for Neisser infection sixteen years ago, lasting five months, and pneumonia with empyema operated on at fifteen years, history is irrelevant. The chest showed an old empyema scar.

The left elbow was swollen and distorted. The whole forearm appeared backwardly displaced, the gross appearance being that of a posterior dislocation of the elbow. There was preternatural mobility of the ulna on the humerus laterally, backward and forward. The elbow was held flexed at one hundred and seventy degrees. There were only ten to fifteen degrees of motion range. The condyles of the humerus had the normal relation to the shaft, but there was a long mass down in front of the internal epicondyle, and apparently attached to it. The head of the radius seemed in normal relationship to the ulna, but in contact with the external epicondyle of the humerus.

Skiagraphs showed backward dislocation of the forearm on the humerus, with fracture of the olecranon. A fragment of the proximal end of the olecranon displaced somewhat upward and rotated forward. Callus is present between the fragment and the shaft of the ulna. This callus involves the joint surface, producing a sort of a hump. In the lateral view two rather long shadows extend obliquely upward across the lower end of the humerus. Two curved, elongated shadows lie on the flexor side of the lower end of the humerus which probably represent calcification in the soft tissues. New bone formation seems to be present on the posterior aspect of the lower end of the humerus.

In no picture or on examination before operation, and on re-examination after the operative findings were known, was it possible to see any evidence of osteomyelitis or joint suppuration.

The temperature on admission was 101° , but under continuous wet dressings became normal and remained so until the day of operation, one week later. All the mild inflammatory symptoms, which were considered traumatic, disappeared. There was no pain or tenderness.

After a two-day preparation he was operated on July 17, 1928. It was designed to do a McAusland type of arthroplasty. It was found that there was union between the fragments of the olecranon only along the outer border. The space between the fragments elsewhere was filled in by dirty, gray, granulation tissue, obviously chronically infected. This cavity communicated directly with the elbow-joint, which contained a moderate amount of cloudy fibrin-flecked fluid. The olecranon fragment was separated and turned up and back with the soft part flap, exposing the elbow-joint from behind. Radial head appeared normal. The joint synovia was thickened and looked like thick purple-red plush throughout. The articular surface of the ulna and the articular surfaces of the humerus showed numerous erosions.

RUPTURE OF THE AXILLARY ARTERY

The cartilage was extremely friable, and covered bone in both instances so soft that the fingers could compress it as it would spongy molasses candy. This bone contained scattered areas of greater softness filled with granulation tissue of the same type as described above. Normal feeling and appearing bone was not found until above the level of the epicondyles. The olecranon fossa contained soft bone and the same granulation tissue as heretofore described. A resection of all infected bone of the lower humerus was done, subperiosteal in the region of the muscular attachments in the neighborhood of the epicondyles, and all infected synovia that could be removed from the capsule was removed. The calcifications in the soft parts were also removed. The separated fragment of the olecranon was dissected from its soft part bed, and the articular surface of the remainder of the olecranon and the bone beneath it was removed. The wound was closed in layers very loosely without drainage. The ulnar nerve had been isolated at the beginning of the procedure, and kept out of harm's way on a tape. At no time was anything resembling caseation or tubercle formation seen.

Despite a long operative procedure the post-operative reaction was extremely moderate. July 26 he was measured for a jointed brace to allow of motion only in the anteroposterior plane. Gross appearance excellent. Painless range of motion from eighty to one hundred and thirty degrees. Thin serosanguineous fluid discharging from the centre of the wound. August 6, 1928, the operative wound was closed. Motion ninety to one hundred and thirty degrees. No pronation or supination. Wearing a brace. October 4, 1928, there was slight lateral instability without the brace, but it is well stabilized by muscle control when voluntarily used. Painless range—full extension to flexion of eighty degrees. October 31, 1928, flexion eighty degrees, extension one hundred and seventy degrees, full pronation and supination. No pain.

He has been back at work since the fourth of October, and today did six hours as a plumber and drove a light truck for two hours.

RUPTURE OF THE AXILLARY ARTERY COMPLICATING EPIPHYSEAL SEPARATION OF THE UPPER HUMERUS

DOCTOR MURRAY presented a youth, sixteen years of age, who was hit by an automobile August 30, 1927. He was taken to the Lenox Hill Hospital, where a laceration and abrasion of his right scapular region, contusions of the right shoulder, and an ecchymosis over the mesial aspect of the right upper arm were discovered. He complained at the time of some numbness and weakness of his right hand. The laceration was sutured. An X-ray failed to reveal any evidence of fracture of the humerus or scapula. He was kept under observation for several days, during which time the numbness and weakness of the hand persisted, and some sensory disturbances were found. He was considered, at that time, to have sustained a direct trauma to the cords of the brachial plexus at the site of the ecchymosis, high up over the inner face of the right upper arm. This spot remained tender during his stay. He complained of moderate pain about the shoulder. He was given physiotherapy, and was discharged to neurological observation in the Out-Patient Department.

Apparently he transferred his attentions to Lincoln Hospital where he was admitted September 8, 1927, complaining of pain in the right arm, some shoulder girdle pain, and numbness and weakness in the right hand and arm. He showed localized tenderness and some thickening in the region of the right upper humeral epiphysis, a healing laceration in the right scapular

region, and an ecchymosis as before described, with the addition of a pulsating mass at this site about one inch in diameter. X-rays showed no bony pathology and it was presumed that his tenderness represented an epiphyseal trauma or separation without displacement, as is frequently seen in the young. The mass on the inner side of the arm, close to the apex of the axilla, was diagnosed as a traumatic aneurysm of the axillary artery. There was at this time apparently little or no sensory change in the hand and arm, but some weakness, particularly in flexion. He was having moderate pain in the arm, and complained of it feeling cold. There was no cyanosis and the pulse seemed good. For the next four days he was treated by heat, rest and elevation, at the end of which time the mass, which was flat and pulsating, had increased in size. At this time he was seeing Doctor Murray, who concurred in the diagnosis of aneurysm and advised operation. At that time the mass was about one by two inches, moderately soft, apparently pulsating, and gave a distinct bruit. Shortly after he became suddenly worse, the pulse on the affected side almost disappeared, and pain, numbness and weakness became marked. At operation, when the deep fascia was exposed it appeared bluish, was extremely tense, and the biceps muscle was spread under it in a thin sheet. With the axillary artery controlled, above and below, the deep fascia was incised, and a tremendous clot shot out of the wound, having been under great tension beneath the deep fascia. There was no trace of any aneurysmal sac, but the torn ends of the axillary were ragged and frayed. The vessel had ruptured in its third part, below the subscapular branch. There had apparently existed a false or dissecting aneurysm, which had effected a gradual disruption of the vessel. The soft parts had been considerably stretched and torn by the tension of the hæmorrhage. The ends of the vessel were doubly ligated, all clot removed, the stretched and torn muscle and fascial tissues restored as much as possible to their normal relations, and the wound closed. He has since then been under physiotherapy, and presents now, after fourteen months, a marked improvement, although there is considerable residual palsy, apparently of brachial cord origin. Pressure over the scar gives marked tingling and pain flashes down the arm into the hand. It is highly probable that a large part of the residual palsy is attributable to the effect of scar tissue compression of the cords at the site of the original injury. His condition has been stationary for at least a month. Attempts to aid the beginning contractures of the fingers by the use of elastic traction on a banjo splint have been defeated by the extremely poor circulation becoming compromised by the pressure. The pulse on that side is barely perceptible.

FRACTURE OF PATELLA—OPEN REDUCTION FOLLOWED BY DELAYED OSTEOMYELITIS

DOCTOR MURRAY presented a girl, eight years of age, who was admitted to the Polyclinic Hospital October 29, 1927. She had sustained fracture of the patella with wide separation of the fragments from a fall down a flight of stairs. She had a temperature of 99.8°, was extremely apprehensive and nervous, and showed a knee-joint full of blood with no surface lesion. The joint was not aspirated. A posterior splint was applied, the leg was elevated, and constant heat kept to it for five days, when an open reduction was done by repairing the tears in the lateral expansions, which were extensive, suturing the synovia by a separate line of interrupted sutures, everting the edges and suturing the fascia over the patella. No sutures were passed through the bone, and no skin sutures were passed, clips being used for skin closure. Profuse dressings without splints and a firm bandage were applied. The

OSTEOMYELITIS AFTER FRACTURE OF PATELLA

leg was elevated and radiant heat applied constantly. Convalescence was normal. At the end of four weeks she was allowed to go home on crutches, being referred to the physiotherapy clinic for further treatment. Two weeks later she returned to the Surgical Clinic because of a very small opening at lower angle of the wound. A chromic knot was discharged through this in a few days and the wound closed up with no further difficulty. Because she was extremely apprehensive the patient was attending the physiotherapy department for the next two months, motion return being slow. However, she was attending school all this time and was by her own story playing normally with the other children. She had secured a solid bony union.

Three and a half months after her first admission, about the middle of February, 1928, she developed some pain and swelling over the knee. Careful examination elicited signs of nothing except a prepatellar bursitis. She denied any trauma, and there was no evidence of any trouble in the joint itself. However, it was desired to leave her in the hospital for observation, but the parents refused to consider it. She was taken home, and used cold wet dressings, and gave the part rest. By February 27, 1928, the swelling and tenderness had increased, and the parents left her at the hospital. She had a temperature of 104° , and showed a hot, red, swollen knee, the pathology affecting apparently the soft parts in front of the patella. She was sent to the operating room, and a suppurative process in front of the patella at the normal site of the prepatellar bursa was opened and drained. A culture taken at this operation reported a pure culture of streptococcus hæmolyticus. X-ray pictures taken in the next few days showed some erosion of the patella, but no pathology in the joint. On March 1, 1928, the temperature having stayed at or above 104° , freer drainage was done because of the possibility that the patellar osteomyelitis was not draining freely. Dakinization was started at this time. On March 5 a blood culture was negative. On March 6 fluid was demonstrated in the knee-joint, and an arthrotomy was done with the idea of instituting the Willems treatment. A transfusion was given at this time. The temperature was now swinging widely between 98° and 105° each day. The attempt at Willems's treatment was a failure. The patient would not move the joint nor would she allow any passive movement. Dakinization down to the joint cavity was instituted, and a gentle lavage of the joint was done at the daily dressing. By March 12 her temperature was 105.4 . She was taken to the operating room, given a transfusion, the patella was sawed through transversely, the halves being turned up and down, and a large posterior drainage of the knee-joint was established in addition. A blood culture taken before the transfusion was negative. Dakinization was resumed, but the patient was given gas for her dressings. Even here she was in a state of collapse before she was anesthetized. Her temperature went along at 103° , and on March 18 she was given another transfusion. For the next three days her temperature was a bit lower, but on March 24 was again 103° . She was put out in the direct sunlight at this time and for three days her temperature dropped to 101° , but on March 28 was again 103° . She was again transfused and put out in the sunlight. The temperature was running along at 103° , and on April 3 she was again transfused. All this time she was being Dakinized, dressed daily or every second day, and put out in the air and sunshine. On the 7th of April, no change having occurred, and the patient obviously having reached her limit of endurance, she was taken to the operating room and all the drainage tracts and the knee-joint were packed with vaseline gauze, a plaster spica was applied, and the patient returned to the ward. That night the temperature was still up. The next morning it was 99.2° and from then on never went above 100° and

averaged about 99° until her discharge to Seaside about the middle of June, at which time she was up and about on crutches. Her first dressing after the application of the spica was done four weeks afterward. All the drainage tracts had healed and the knee-joint was healed over with bright clean granulations. Another spica was applied for ten days and when it was removed, except for the surface granulating area, which later healed without skin grafting, there was complete healing. She now has a fibrous ankylosis at an angle of about 150 degrees.

Of interest is the question as to the origin of this infection by hæmolytic streptococcus. It is inconceivable that a wound healing by primary union, and a patella healing by solid bony union, this organism could have been introduced at operation and lain dormant, to suddenly break forth three and a half months afterward. The possibility of a hæmatogenous origin for this infection seems very strong, and is worthy of discussion.

DR. FRANK L. MELENEY (by invitation) considered the most important question in this case was how the organism gained entrance so as to affect the patella. This must have occurred at one of three times: During the original operation; at the time the chronic suture worked its way out; or, later, just before the time of the last admission to the hospital. The course of the case would indicate that it did not get in at the time of the original operation, for a hæmolytic streptococcus infection usually causes an immediate and rather sudden rise in temperature. The temperature, however, in this case came down immediately after operation. Likewise, from the appearance of the wound, both during the post-operative course and at the time the patient first left the hospital, there was no evidence of infection. Neither does it seem that streptococci could have been introduced at the time the chromic suture came out, or that they could have been in the catgut when it was imbedded. It should be remembered that it is very easy to destroy streptococci in catgut by even incomplete "sterilization" processes. There was certainly no evidence of acute inflammation while the wound was healing after the chromic catgut was removed. The most probable time of infection was just before the acute inflammation developed; that is, just before she entered the hospital the last time. But it is a puzzle how the organism did get in and why it localized where it did. It is common to see cases of such infection where there has previously been traumatized tissue. When patients look back to a previous trauma and attribute that as the starting point, of tuberculous infection, for example, it is impossible to prove that trauma really has been the cause; but almost every surgeon has seen cases in which there has been immediate injury which caused localization of organisms out of the blood.

Doctor Meleney remembered three cases perfectly well. The first was a patient who had a staphylococcus osteomyelitis of the femur. The boy had been at home for some time before coming to the hospital. Just before coming in he had a sore throat. A blood culture was taken and was positive for hæmolytic streptococcus. At the time of operation a pure culture of

PYLORIC EXCLUSION FOR DUODENAL ULCER

staphylococcus aureus was obtained from the femur. On the next day after operation hæmolytic streptococcus was also found in the wound. This was a case of direct injury. The second case was one of fracture of the os calcis. At the same time the patient had a boil on the back of the neck. He developed acute osteomyelitis of the os calcis at the site of fracture three days afterward. The third case had an abscess of the neck and was a very sick man; he showed a positive blood culture of hæmolytic streptococcus. At the time of operation he was turned on his right side in order to expose his lesion and during the operation his elbow was pressed underneath his body in an unusual attitude. This was noted at the time and the point raised with regard to possible localization of the organism at that site. The day after the operation he developed acute signs of arthritis of the elbow-joint and a very severe purulent infection on the second day. This was opened and with his coöperation under Willems's treatment, perfect function resulted.

Apparently, although there was no direct injury to the blood vessels, there was a delay in the circulation of the blood in the part long enough for the organisms to gain a foothold. With these illustrations of trauma preceding joint infection, or rather, during the course of joint infection, where proof is quite good, Doctor Meleney thought it might be assumed that some of these early traumas likewise injure tissues to a point where the organisms going through the blood stream could become localized at the site of trauma. In the case presented the organisms were probably introduced either directly through the skin, or from the throat, without any extensive degree of local inflammation at the point of entrance and localized in the previously traumatized patella.

PYLORIC EXCLUSION FOR DUODENAL ULCER

DR. FREDERIC W. BANCROFT presented a man, thirty-nine years of age, who was admitted to the Fifth Avenue Hospital January 9, 1928. Patient has been having indigestion for the past eight or ten years. For the last four or five years he has suffered from a severe epigastric pain coming on one or two hours after meals. The pain is relieved by taking food. The pain is dull usually, but at times is sharp and severe and radiates toward the tenth intercostal space in the back. His blood count was: red blood cells 5,400,000, white blood cells 10,000, polymorphonuclear leucocytes 68, hæmoglobin 110.

The X-ray examination revealed an ulcer on the cap, which extended to within about a half inch of the region of the papilla of Vater. There was no six-hour retention. From the X-ray it was evident that there was too much contraction to attempt any form of pyloroplasty. Any type of subtotal gastrectomy would be difficult because the induration of the ulcer extended so far toward the descending portion of the duodenum that inversion of the duodenum would be an extremely difficult and dangerous procedure. Devine, in January, 1925, advocated the operation of pyloric exclusion. As described by him a clamp is inserted through the avascular zone of the transverse of the mesocolon, and inserted across the stomach at about the reëntrant angle. Another clamp is put over the antrum just distal to the first. The stomach in this region is then cut through and the pyloric antrum is inverted

with a double inverting suture. The proximal portion of the stomach is then drawn through the mesocolon and anastomosed to the duodenum near the duodeno-jejunal junction by a Polya anastomosis. Devine assumes that the mucous membrane of the pyloric antrum, put at rest, will atrophy, and, therefore, the acid-secreting portion of the stomach will be diminished and the ulcer will heal by being put at rest. Dr. Lewis Gregory Cole suggested a modification of this operation, as follows: After cutting across the antrum, Allis clamps are inserted onto the antrum—opening it wide. The mucous membrane is then dissected free and excised over the entire pyloric antrum down to the pyloric muscle. The stump of the mucous membrane is closed with an inverting suture. The muscularis is closed over it, and peritonealization accomplished by an inverting suture. This procedure removes the acid-bearing mucous membrane, allows an easy and satisfactory closure of the pyloric end, and is not as difficult a procedure as a subtotal gastrotomy. The remainder of the operation is performed as described by Devine.

This operation has been performed four times. In the first three cases there was considerable ooze in the dissection of the mucous membrane from the pyloric end. In the last case this was controlled by inserting a clamp beneath the pylorus and drawing through a rubber band which was tightened, acting as a temporary tourniquet for the vessels in the region of the pylorus. In this case dissection was easy, with very little ooze.

This operation was performed on this patient January 13. He was discharged from the hospital on his nineteenth post-operative day. His convalescence was uneventful. Since that time he has gained twenty pounds in weight, works twelve hours a day in a grocery store, and has no symptoms of any indigestion. Doctor Cole's report of the X-ray findings on January 31, 1928, are as follows: Films of the stomach immediately and four and a half hours after a barium meal show the remaining portion of the stomach and the anastomosis between the stomach and the jejunum. The barium starts out of the stomach immediately without any obstruction or delay. The loops of the anastomosis are shown distinctly. There is a slight angulation at the superior border of the anastomosis due to the distal loop of jejunum dropping or pointing downward. At four and a half hours there is considerable gastric retention. We believe this is due to a twist or angulation in the region of the stoma and not due to a constriction or definite obstruction. At twenty-four hours the stomach and small intestines were entirely empty. The proximal half of the lumen of the appendix is very narrow and filled and directed upward. This region, however, is movable under fluoroscopic manipulation.

The X-ray findings of May 1, 1928, are as follows: Films of the stomach made immediately and six hours after a barium meal show the stoma functioning normally and the stomach empties itself within the six-hour period. The slight angulation in the jejunum at the site of the stoma is the same as reported previously. The cicatricial deformity of the cap is still present and this fills by the barium going backward through the proximal loop of the anastomosis. There is no X-ray evidence of an ulcer at the stoma.

This operation has a certain definite indication in cases of duodenal ulcer where the ulcer extends along the second portion of the duodenum and wherein inversion of the duodenal stump would be difficult and hazardous because of its proximity to the papilla of Vater. The operation is of less risk than the subtotal gastrectomy because of the easy closure of the pyloric

VARICOSE VEINS

antrum, and the fact that the blood supply in the lesser and greater curvature is very little interfered with. This case is presented to illustrate an operation which is of value in a limited type of case. It is admitted that there is not sufficient length of time for follow-up to determine what its late results will be; but until now the patient's post-operative course and convalescence have been very satisfactory.

ADENOMYOMA OF RECTOVAGINAL SEPTUM

DR. FREDERIC W. BANCROFT presented a woman, thirty-eight years of age, because this lesion is usually mistaken for malignancy of the rectum, and usually an extensive operation is performed which is not always necessary. She was seen by him first in January, 1927. This case was reported in detail in *Surgical Clinics of North America*, in the New York number, October, 1928.

VARICOSE VEINS

DR. FREDERIC W. BANCROFT said that in the present day of sheer stockings, short skirts and bare legs in bathing suits, varicose veins or scars on the legs following operation for varicose veins are considered unsightly. For this reason any method that will obliterate veins without operative procedure is to be seriously considered.

Varicose veins may be subclassified into the following types: (a) Varicose veins without infection. (b) Varicose veins with infection. (c) Varicose veins with ulceration. (d) Varicose veins with ulceration and arteriosclerosis. (e) Varicose veins compensatory to (1) deep obstruction, (2) pressure from pregnancy or tumor in pelvis, (3) cardiovascular decompensation.

Obviously, varicose veins with infection and varicose veins due to compensatory hypertrophy on account of deep obstruction are inadvisable for this type of treatment. Varicose veins without infection and varicose veins with ulceration are satisfactorily treated. The theory of the injection treatment is that the drug acts as an irritant and causes obliteration of the intima.

During the past year over twenty cases of varicose veins had been treated by Dr. Stanley Brown, at the speaker's instigation, in the Out-Patient Department of the Fifth Avenue Hospital, by the injection method.

The average case requires four to six injections, but a few more difficult types require from eight to ten.

In this series of twenty cases all but one had been treated with sodium salicylate. The patient is put in a sitting position, with the leg dropped over the table. A small hypodermic needle is then carefully inserted into the lowest radicle of the dilated vein. Care should be taken to see that the needle is within the lumen of the vein. The leg is then slightly elevated, so that it is empty, and two to five cubic centimetres of a 20 to a 40 per cent. solution of sodium salicylate slowly injected. At the first injection it is the custom to use one cubic centimetre of a 20 per cent. solution of sodium salicylate to test out whether the patient has any idiosyncrasy to salicylates. If no idiosyncrasy is present, five days later one to three cubic centimetres of the

NEW YORK SURGICAL SOCIETY

40 per cent. solution may be used. The patient is kept quiet for about ten minutes, after which she is allowed to go home without wearing any bandage.

Following the injections the patient generally feels a burning sensation along the course of the vein. There may be a cramp in the muscles of the calf, but this lasts only for a minute or so. Occasionally a periphlebitis, with some tenderness and induration along the course of the vein, occurs. Wet dressings applied at night usually relieve discomfort, and it is not necessary for the patient to remain in bed. In three of their cases they have had small sloughs at the region of injection, as there was some leakage from the vein or the needle was not satisfactorily inserted.

Doctor Bancroft then presented five cases to illustrate this method.

FACIAL PARALYSIS AND ITS SURGICAL TREATMENT

DR. HERMANN FISCHER read a paper with the above title, for which see page 334.

TRANSACTIONS

OF THE

PHILADELPHIA ACADEMY OF SURGERY

STATED MEETING HELD DECEMBER 3, 1928

The President, DR. ASTLEY P. C. ASHHURST, in the Chair
CALVIN M. SMYTH, JR., M.D., Recorder

STENOSIS OF THE COMMON BILIARY DUCT IN AN INFANT

DR. JOHN O. BOWER, by invitation, remarked that in the *ANNALS OF SURGERY*, July, 1928, he reported a case of "Congenital Absence of the Gall-bladder, Cystic and Common Ducts." The review of the literature was as complete as the library of the College of Physicians permitted and included a case reported by Bergman in the year 1701 and one by Littre in 1705. During the investigation a large number of cases of Congenital Stenosis of the Common Duct were found. The majority of these were associated with absence of the gall-bladder and absence and stenosis of the hepatic and common ducts. Most of these anomalies were discovered at autopsy. A few were operated upon. Theodor in 1908 reported the case of a male child, six weeks of age, on whom he did an hepatico-colangio-enterostomy, who died eight days after the anastomosis. The gall-bladder and cystic duct were absent. In 1913, Toygaus operated upon a five-year-old girl for jaundice and abdominal pain who had an obstruction close to the Papilla of Vater—the gall-bladder, cystic and common ducts were enlarged. He thought that there must have been a congenital narrowing or valve-like obstruction in the common duct. A cholecystectomy was first done but the child became progressively weaker. Four months later the common duct was anastomosed to the duodenum and the child became strong and well. In 1927 Derwissieu operated upon a child, female, two and one-half years of age for suspected hepatic echinococcus cyst. Cholecystostomy was done with a stormy convalescence but no jaundice. The fistula did not close for six weeks and attempts to close it resulted in pain and bile retention. Cholecystogastrostomy was then attempted but the child died. Autopsy revealed that the choledochus was .5 centimetre in length and that a fold or obstruction was situated at the junction of the right hepatic and common ducts. These were the only cases that the reporter could discover that were operated upon for congenital stenosis of the common duct. He then reported the following case:

A child, twenty-one months of age, with a perfectly negative history as to delivery and up until the age of one year when she developed bronchitis accompanied by a slight fever and cough. She was not confined to bed. At the end of several days a gradually increasing jaundice developed. This was associated with abdominal discomfort. The child flexed her thighs on

PHILADELPHIA ACADEMY OF SURGERY

the abdomen and refused to lie in the prone position. She vomited constantly. Urine became dark in color and stools were constipated and of clay color. This was of two months' duration. She was then taken to the Children's Hospital, where, following medical treatment, the jaundice disappeared in ten days. Following this she was well for six months. About August, 1927, she had an attack similar to the first; the jaundice was preceded by bronchitis and accompanied by abdominal pain. There was no

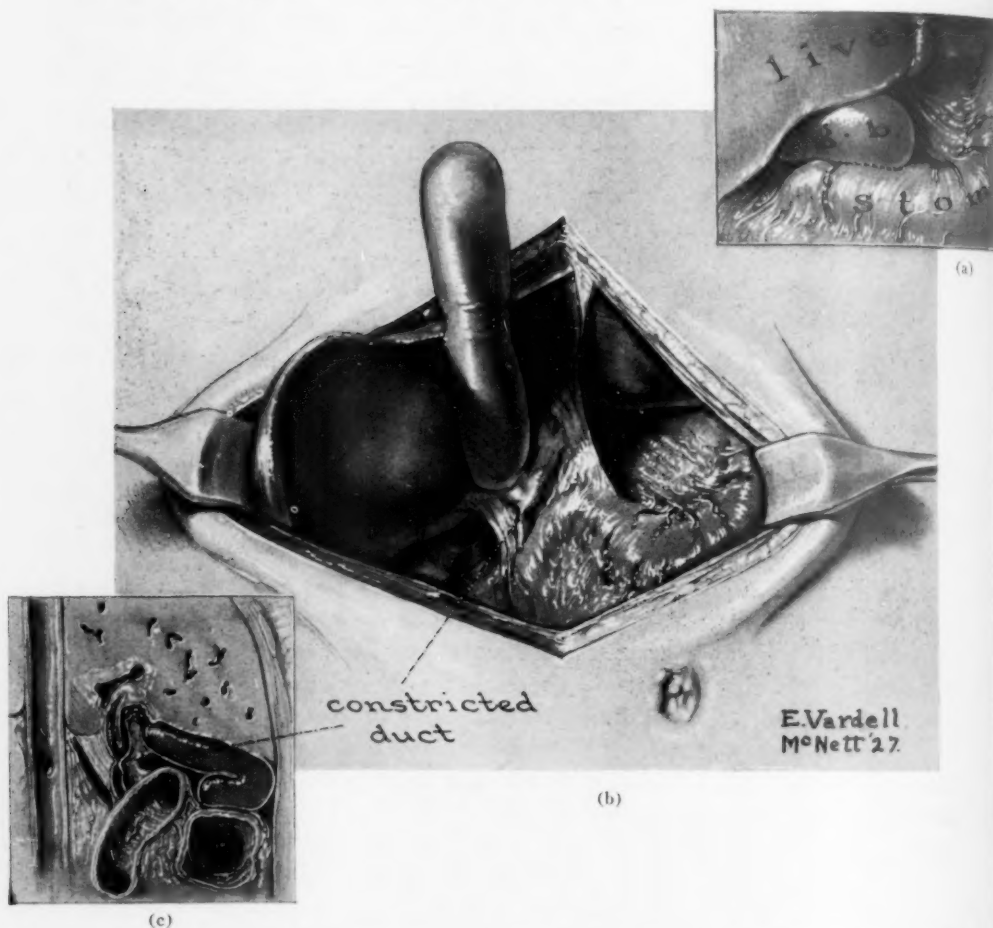


FIG. 1.—Illustration Showing (a) Cross-section of Abdomen with Acutely Flexed Gall-bladder and (b) Constricted Duct and Elongated Gall-bladder Protruding from Abdominal Incision and (c) Anas-tomosis of Gall-bladder to Stomach.

loss of weight. She was admitted to the Samaritan Hospital on August 12, 1927, with marked jaundice, abdominal pain, putty-like stool and dark urine.

Gastro-intestinal X-ray was negative. Twenty-four hours prior to operation the temperature was 105 by rectum, pulse 150. Immediately before operation temperature was 102.6, pulse 140. At operation August 27, 1927, under ethylene oxygen combined with novocaine anæsthesia, a moderate amount of slightly blood-tinged fluid was found in the peritoneal cavity. There was no evidence of fat necrosis. The stomach was normal in size; duodenum normal, no adhesions. Gall-bladder was not visible but covered over by omentum which was not adherent. The index finger directed posteri-

STENOSIS OF COMMON BILIARY DUCT IN AN INFANT

only showed the gall-bladder acutely flexed upon itself from above downward. Upon releasing the kink the fundus of the gall-bladder immediately presented itself about one centimetre outside the abdominal wound. It was markedly tense, cylindrical in shape and projected about three centimetres above the edge of the liver. It was about fifteen centimetres in length. No calculi were felt. The cystic, common and hepatic ducts were distended. The common duct was stenosed directly below the junction of the cystic and

common ducts. A finger in the foramen of Winslow disclosed no pathology. The pancreas was slightly swollen. The liver was slightly larger and darker than normal, surface mottled but there was no visible evidence of cirrhosis. The gall-bladder wall was grayish-blue and about three times its normal thickness. About forty cubic centimetres of bile were removed by aspiration. An anastomosis of the lateral aspect of the fundus of the gall-bladder, beginning about 1.5 centimetres from the extreme, was made into the stomach directly proximal to the pyloric vein. The opening was about 1.5 centimetres. A cigarette drain was placed directly below the anastomosis and the closure was completed with chromic catgut and interrupted sutures of silk. Directly following the operation the child was given thirty cubic centimetres of mother's serum intramuscularly. Enemas containing twenty grains of calcium lactate, four drachms of glucose and three ounces of water were given every three hours. Twelve hours after the operation the child vomited bile-stained mucus, and twenty-four hours after operation bile-stained fluid was siphoned from the rectum. Thirty-six hours after operation she passed a liquid green stool and at the end of forty-eight hours expelled considerable flatus. Forty-eight hours after operation the temperature was 99.4, pulse 100. Following this, there was a slight rise in temperature and pulse which gradually dropped to normal within four days. Fluids were given by mouth and gradually increased until at the end of seventy-two hours the child was taking semi-solid food. The drain was removed on the fourth day. Following this the child's recovery was uneventful. The wound healed primarily and the child was discharged from the hospital October 5, 1927.

She returned to the follow-up clinic, January 25, 1928, and radiographs were taken following the administration of bismuth. No evidence of bismuth



FIG. 2.—Photograph of Child Fifteen Months After Operation.

PHILADELPHIA ACADEMY OF SURGERY

could be demonstrated in the gall-bladder. Fifteen months after operation the child is in excellent health, has had no recurrence of jaundice, stools and urine are normal.

DOCTOR BOWER added that in attempting to correlate the symptoms and signs present in this case with the pathology found at operation, two pertinent questions present themselves. First, if a stenosis of the common duct was present at birth why should the development of symptoms be delayed for a year? Second, what part did the acutely flexed fundus play in the pathology? Regarding the first point it seems to be a well-established fact that a very close relationship exists between the quantity of the end products produced by the liver and the amount required to adequately supply the physiologic needs of the body. This is clearly demonstrated in the reports reviewed. One infant lived 216 days; another 150 days with complete absence of the gall-bladder, cystic, common and hepatic ducts, and the average duration of life for the thirteen cases reported was seventy days. Absence of the gall-bladder, cystic and common ducts is compatible with normal existence, if the hepatic ducts empty into the duodenum. Cases have been reported in which the anomaly was found to be present in patients operated upon for conditions other than biliary disease. Several of them had passed their sixtieth year. It would appear from the cases cited that individuals with congenital defects in the biliary passages can maintain an apparent physiologic balance until certain conditions arise which interrupt it. It will be recalled that in the case reported the two attacks of jaundice were preceded by a respiratory infection. Regarding the second point the speaker believes that the acute flexion of the gall-bladder was a sequence of common duct obstruction due to infection. It could not be confused with torsion of the gall-bladder, similar to the eighteen cases reported by Sutter in 1925. These cases occurred in adults and were usually associated with gall-bladders having long mesenteries. Neither could it be confused with the acute flexion as reported by Bartel (forty cases) in which a groove began below the tip, vertical to the long axis of the gall-bladder and extended over half its surface, giving the gall-bladder the appearance of a tobacco pipe; these cases were observed in adults and were not associated with jaundice. Acute torsion and flexion can therefore be ruled out in this case.

ENTEROTOMY FOR INTESTINAL OBSTRUCTION

DR. JOHN B. FLICK remarked that not infrequently, in acute intestinal obstruction, the propulsive power of the overdistended gut above the block is so impaired that even after the obstruction is relieved the faecal contents and gas remain stagnant. Absorption of this highly poisonous material constitutes the greatest danger. It is logical, therefore, in certain cases, even if enterostomy is to be performed, to first empty the intestines as completely as possible. In the cases herein reported the performance of enterotomy became almost a necessity because of inability to replace, without risk of injury, distended intestine which had been forced through the abdominal wound.

ENTEROTOMY FOR INTESTINAL OBSTRUCTION

The first case, a negro thirty-nine years of age, was admitted to the Pennsylvania Hospital August 29, 1927. He gave a history of appendectomy with drainage one year previous. He apparently had had an obstruction for five days as indicated by his history. After gastric lavage and hypodermoclysis his abdomen was opened. The peritoneal cavity contained a large amount of clear amber fluid. During exploration small intestine escaped through the wound and could not be replaced. The obstruction was due to a band of adhesion running to the cæcum just above the appendectomy scar under which a loop of intestine had been caught. This was divided and the collapsed bowel distal to the point of obstruction was at once seen to fill. A small incision was made in the ileum and about a quart of liquid faecal matter and much gas emptied out. The incision in the ileum was closed by a purse-string suture and this inverted. The abdomen was closed without drainage. A tube of the Rehfuß type was introduced into the stomach on the following day and left in place. The patient died seventy-two hours after operation. The autopsy showed distention of the stomach and intestines except the colon which was contracted. The intestines were described as dark in color and matted together by thin fibrinous adhesions with marked kinking. No leakage had occurred at the site of enterotomy, but on careful examination a small amount of pus escaped from the holes made by the sutures.

This patient obviously was operated upon too late and perhaps should have received the possible benefit of an enterostomy, after emptying the bowel.

The second case, a negro twenty-six years of age, was admitted to the Pennsylvania Hospital January 26, 1928. He gave a history of an operation for appendiceal abscess in 1918 and for intestinal obstruction in 1926. He apparently had had a partial obstruction for eight days which now was complete. He had a small bowel movement following an enema forty-eight hours before operation. When the abdomen was opened there was considerable free fluid in the peritoneal cavity. The obstruction was due to a band of adhesion under which a loop of small intestine had been caught. This was divided. The small enormously distended intestine was emptied through a small incision in the ileum. Over two quarts of fluid and much gas escaped. The opening was closed with two rows of o chromic gut sutures. The intestine was replaced and the omentum pulled down over it. The abdomen was closed without drainage. The patient was given 500 cubic centimetres of normal saline solution intravenously. He made a good recovery.

The third case, a negress forty-nine years of age, was admitted to the Pennsylvania Hospital August 27, 1928. She gave a history of two previous operations, one for a kidney and the other for a pelvic condition. Rectal examination failed to reveal a growth. She was well until sixteen days before operation when she developed sharp abdominal pains and vomiting. She continued to pass gas until about two days before operation. When the abdomen was opened both large and small intestine were found congested and enormously distended. Several coils of small intestine at once escaped from the abdominal cavity. On puncture much gas escaped and a small amount of liquid faecal matter. The opening in the small intestine was closed with two rows of o chromic gut sutures and the intestine returned to the abdominal cavity. The distention was sufficiently relieved to permit satisfactory exploration. A hard growth was felt in the lower sigmoid. A left inguinal colostomy was then done, the bowel being opened at once and a mushroom catheter fixed in place. The original abdominal incision

was closed without drainage. The patient made a good recovery except for wound infection and left the hospital refusing operation for removal of the growth.

DR. DAMON B. PFEIFFER remarked that he had come to regard enterostomy or jejunostomy as of the greatest value in those conditions which follow inflammatory conditions in the lower abdomen, such as peritonitis or tubal infection. In such conditions there is a time post-operatively when the intestines are matted together by plastic lymph; they become knuckled about the drainage which has been inserted and as a result of paralysis due to infection and distention, the coils are caught in lymph and there develops a more or less marked obstruction, and yet the patient's condition may be entirely satisfactory so far as the infection itself is concerned. The infection may be limited to the field of operation and still be accompanied by obstruction symptoms. If the patient survives, the intestines may liberate themselves in a few days and there is then no further trouble with the passage of bowel contents. However, the condition may become acute and it is not possible to wait for this to relieve itself, and this is where enterostomy seems to be a life-saving procedure. In the last few months he had met with cases in which he felt that the patients would not have recovered without enterostomy. A few days after the obstruction subsided; nothing was passed by the tube which was then removed, and the wound was closed without leakage. Recently, he used this procedure as a prophylactic measure in a case of pelvic abscess of unknown origin. It was necessary to drain the abscess and it seemed that the measures necessary to establish this would cause distention and death unless relief of tension in the bowel was provided for. In that case the procedure was of great value. So far as immediate enterostomy for intestinal obstruction he had always felt that there was a great danger because of the possibility of causing peritonitis. There is no rule more binding on the surgeon than the one not to do an anastomosis in obstruction. If one makes an enterotomy and then closes it up, the patient is submitted to the possibility of fluid and gas causing pressure, as happened in the first case reported by Doctor Flick where there was tension on the sutures, with leakage and peritonitis. The speaker distinctly preferred enterostomy, the opening protected by a piece of omentum.

DR. GEORGE M. DORRANCE said that he had been confronted by cases after appendix lesions with acute obstruction low down in the ileum about six inches above the ileocaecal valve—as in Doctor Flick's last case. He thought if the caecum could be delivered and a caecostomy made placing a catheter into the ileum to relieve pressure, it would be desirable. In one case the procedure had worked very well. The catheter may be easily slipped through the ileocaecal valve into the small intestine. In appendiceal cases with obstruction low down he intends to use this procedure, rather than the higher one. It is well known that when these appendiceal cases get a faecal fistula they get well.

ENTEROTOMY FOR INTESTINAL OBSTRUCTION

DR. EDWARD T. CROSSAN said that in 1920 Doctor Codman wrote a paper on intestinal obstruction in which he reported twenty-seven cases without a death. In this paper he advocated enterotomy and said he thought it a life-saving procedure. The speaker's own experience has been that it was not worth while. Doctor Codman did an enterotomy in all his cases but in eight it was combined with enterostomy. As to intestinal obstruction following acute appendicitis Doctor Crossan recently tried to separate the adhesions in a case of this type and the following day the patient had an intestinal obstruction and he had to do an enterostomy.

DR. HENRY P. BROWN, JR., said that in view of the fact that the toxic manifestations of obstruction are due to absorption from the bowel, that any method which will empty the bowel of its toxic contents will correspondingly diminish the resulting toxæmia. Evacuating the bowel of toxic contents in acute obstruction has recently been suggested. He had adopted this procedure several times with very gratifying results. In one recent case of acute obstruction of the terminal ileum of twenty-four hours' duration, the patient being quite toxic, after relieving the obstruction, a rubber clamp was placed below the site of the obstruction, and a catheter was sutured in the bowel just above the clamp. After greasing the hands and grasping the first part of the jejunum between the index and middle fingers of the right hand the assistant pulled the entire small gut through the reporter's fingers down to the site of the clamp, thus emptying the bowel of its gas and toxic contents. The catheter was then removed, the opening in the bowel closed, and the abdomen sutured in layers without drainage. Aside from slight post-operative nausea from the anæsthesia, the patient never vomited, the temperature was never above 100, and he made a good recovery. This procedure empties the bowel of its gas and toxic contents more efficaciously than when merely an enterostomy is performed.

DR. ASTLEY P. C. ASHHURST said: *First*, as regards enterotomy for acute intestinal obstruction; about twenty years ago or more Moynihan advocated efforts (during the operation) to secure evacuation above the obstruction by opening the bowel about a foot (30 cm.) or higher above the point of obstruction (after relief of the obstruction), inserting a glass tube and crowding on the tube as much bowel as possible. Moynihan said that upon a tube six inches in length six or ten feet of intestine could readily be drawn, the contents evacuated through this tube, the intestinal opening closed, and the bowel replaced. The speaker has tried this method but never could succeed in getting more than one coil of small intestine upon the tube at one time, nor in securing any evacuation. *Second*, as to *enterostomy* (jejunostomy or ileostomy) at the same time as the original operation, or subsequently because the patient was not doing well: Doctor Ashhurst has never had any success at all with this method, as a secondary operation—the bowel simply did not drain, and the patients died. As a primary operative procedure, he has had one temporary success: by opening the first distended coil of bowel that presented, he saved a woman from immediate

death, but she lived only about four months, never regaining sufficient strength to justify a search for the site of obstruction and closure of the faecal fistula. It is a good rule in intestinal obstruction never to make the incision in the mid-line or near it, if the abdomen is much distended. In cases with great distention it is safer to make the incision to one side or other, according to the indications, and to do an enterostomy, a caecostomy or a sigmoidostomy above the site of obstruction, but without any search for the latter. If the patient survives, as many of them will do when the obstruction is in the large bowel, the obstructing lesion may prove amenable to a secondary operation. If one opens in the mid-line, when the abdomen is much distended, one must be prepared to do something to the small intestines when they prolapse. They will become much more distended as soon as they escape, and it will be extremely difficult to replace them. Multiple needle punctures may evacuate enough flatus to enable the surgeon to reduce them, but usually the patient does not survive. When the greatly distended bowel is opened in the presence of acute obstruction it is very difficult to prevent peritonitis unless the bowel is kept outside of the abdomen permanently. Even if the wound in the bowel is carefully sutured and does not leak subsequently, there is very apt to be enough contamination during the operation to produce peritonitis subsequently. This may have been what occurred in Doctor Flick's first patient, the case in which the intestine was closed so nicely, no leakage occurring, but the patient dying of peritonitis all the same.

DR. JOHN B. FLICK said that it was because of the great difference of opinion concerning enterotomy that he had thought it would be worthwhile to report these three cases. Among those who believe in it is Moynihan, who states in his book that no operation for acute obstruction can be considered complete which leaves an overdistended intestine whose function it is to absorb contents of a poisonous nature. He advocated enterotomy and does not seem to fear contamination or peritonitis. All three of the reported cases were acute obstruction. One may have been chronic obstruction but it was acute at the time of operation.

SURGICAL TECHNIC

DR. WALTER G. ELMER read a paper with the above title, for which see page 328.

DR. ASTLEY P. C. ASHHURST remarked that many of the breaks in technic which Doctor Elmer has suggested may be avoided by foresight. Of course all the dressings and other materials to be used in an operation are supposed to be sterile when they come from the sterilizers; but they should be proved to be so before they are used. Every time the autoclave is put into use at the Episcopal Hospital, and at the Orthopædic Hospital, a package is sent from the centre of the autoclave to the laboratory; and every time the water sterilizer is refilled and the water is sterilized, a sample of the supposedly sterile water is sent to the laboratory; and neither the

SURGICAL TECHNIC

gauze, etc., from the autoclave nor the water from the sterilizer is permitted to be used until the laboratory has sent a report that the samples give no bacterial growth on culture media after incubation for forty-eight hours. He regards these precautions as important.

Clean operations should be done early in the day, when possible, leaving the infected cases, such as prostatectomies, operations for pyothorax, etc., until the last. The "suture nurse" should act only as a distributing station, and never as a receiving station. Never let the nurse have any instruments in her hand, except such as she gets from her own table. The instruments which the speaker uses are handled by no one but himself. The nurse hands out from her own table the fresh needles, etc., but when the operator is through with them they are placed in a pan where she cannot reach them. The nurse changes her gown and gloves for every operation, just as the surgeons do. Any blood stains on the sheets under the patient should be covered with something dry (and sterile) as soon as possible, and before anything touches them. Instead of washing his fingers in sterile water, the speaker prefers to use bichloride of mercury solution, because in this way a little bichloride of mercury is carried into the wound each time; before intraperitoneal manipulations, the bichloride may be rinsed off in saline solution. In abdominal surgery there is little chance for the draping sheets, etc., to become displaced, because the patient's position is not changed during the operation. This is not true in fracture surgery because in operating on limbs it is often necessary to move them, and great care is necessary that no unsterile skin area become exposed, and thus permit infection of the wound. With equally careful technic, infection is no more apt to occur in fracture work than in abdominal operations.

DR. DEFOREST P. WILLARD said that he had followed out for years the plan of keeping the wound or the supposedly sterilized surface away from the table by the use of a rubber sheet. He recalled one case in which the technic slipped up and in which he did not use the rubber sheet in which case, obviously, infection developed from the sandbags under the patient. Following an operation on the tendo Achillis the patient was turned over in order to do the bone work on the front part of the foot. Three days later the tendo Achillis wound broke down. The wound on the front of the foot remained clean. Doctor Willard felt sure that the slight amount of blood oozing from the tendo Achillis wound stained the sheet over the sandbag and enough came through to cause the infection. In operations on the extremities the greatest care is taken to see that instruments and sutures do not drag over the skin. The easiest way to protect the wound and sutures from infection is to cover the extremity with a sterilized stockinet. The incision is made through the stockinet and it is sutured to the edge of the wound so that at no time during the operation do the sutures or instruments touch the skin.

BRIEF COMMUNICATIONS

BRAIN ABSCESS SPATULÆ

IN THOSE instances in the management of brain abscesses where it seems advisable to use drains made of rubber tissue or rubber tubing there arises the difficulty of placing the drain accurately and carefully to the proper depth in the cavity. It is highly important that such a step be done under

direct vision, not only that the drain be placed in the depths of the cavity, but that multilocular pockets shall not be overlooked. The various brain abscess "finders" now in use have the disadvantage that the accompanying drains are not inserted directly under vision. Withdrawal of a needle once in an abscess in order to incise the cortex down to the cavity not infrequently results in "losing" it.

The use of the three pairs of concave spatulæ of graduated sizes, shown in the accompanying sketch, is offered as an effective means of visualizing the depths of a cavity and obviates the hazards of "losing" a cavity by withdrawing a needle once in place.

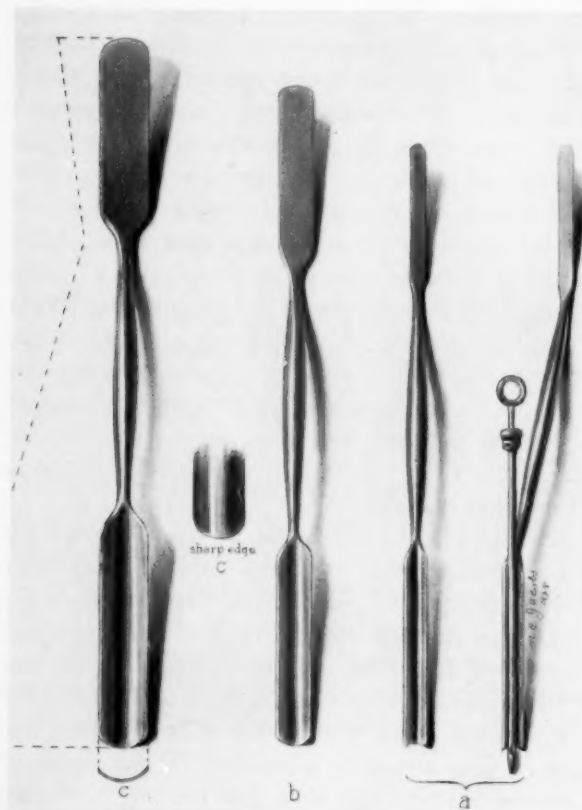


FIG. 1.—Brain Abscess Spatulæ.

The smallest pair of spatulæ (*a*) are gently passed, one at a time, down the sides of the needle to the proper depth. After removing the needle a small glass suction tip is used to empty the cavity in part until an idea of its size can be obtained. If it is a large one the second pair of retractors (*b*) are then inserted about the first pair and so on. By this means the cavity can be thoroughly inspected and a drain of any size carefully placed.

WILLIAM P. VAN WAGENEN, M.D.
Strong Memorial Hospital, Rochester, N. Y.

VOLVULUS OF THE CÆCUM

VOLVULUS OF THE CÆCUM

M. S., male, age forty-one, was admitted to St. Joseph's Hospital of Baltimore July 1, 1924, with pain in abdomen, vomiting and inability to get bowels moved.

Personal History.—General health good; mumps, measles, chicken-pox in childhood. Gastric ulcer since 1917. Several hæmorrhages. No other serious illness. Has had multiple fibromata molluscæ of body, head and extremities since childhood, Von Recklinghausen's disease. No history of constipation. Present illness: June 28, 1924, afternoon was taken with cramp-like pains in abdomen. Thinking exercise would relieve them, he played golf vigorously for several hours. Pains persisted until 1:30 A.M. next day when he sent for his physician; enemata were ordered but were ineffectual, pains continued throughout the day, and following day. About 1 P.M. of July 1 he began to vomit and to have hiccough. With the onset of hiccough and vomiting, the pains in the abdomen became somewhat less and he began to have heartburn and abdominal distention. He was then sent to St. Joseph's Hospital.

On admission his pulse was seventy-two, mouth temperature ninety-seven Fahrenheit, rectal temperature ninety-nine and two-tenths Fahrenheit, respirations, thirty. He was a well-developed, well-nourished white man.

His abdomen was somewhat distended, liver dulness obscured by tympany; spleen and kidneys not felt.

No tenderness anywhere except over right side at level of the umbilicus. No dulness in flanks.

On tapping over right lower quadrant a splashing and sense of fluctuation is made out. Peristaltic sounds not heard.

On opening the abdomen by incision, outer border right rectus muscle, the small intestines were all distended but with marked constriction at the junction of ileum and cæcum.

A large fluctuant tumor filled the abdomen, extending from the right hypogastrium upward and across abdomen, pressing against the diaphragm on left side. This tumor, size of a watermelon and similarly shaped, was delivered and found to be an enormously dilated cæcum filled with liquid feces, measuring forty-five centimetres long and thirty centimetres in diameter largest part; mounted on this is the appendix; the tumor is dark red, almost purple, and in places small islands, green in color, indicated gangrene. A marked constriction was found at the junction of the ileum and cæcum and also at the ascending colon with cæcum, due to a twisting of the cæcum at these two points, the direction being from right to left, on patient, clockwise, almost a complete turn.

The tumor was untwisted, the entire cæcum was cut away from the ileum beyond the line of constriction, and also in same manner was divided from the ascending colon, preserving as much of the mesentery and vessels as possible.

BRIEF COMMUNICATIONS

The cut ends of the intestines were inverted, and a lateral anastomosis was then made between the ileum and ascending colon; drains of gauze wrapped in rubber tissue were placed in the pelvis and wound closed to drains.

Patient returned to bed in fair condition, somewhat shocked. Normal salt solution fifty-five cubic centimetres given subcutaneously, and by Murphy rectal drip, glucose and bicarbonate of soda administered. Uncomplicated convalescence followed and at the end of three weeks he left the hospital for home, wound healed.

February 9, 1928, patient states he is fully well and has been so since operation.

FRANCIS JOSEPH KIRBY, M.D.,
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BOOK REVIEWS

A TEXT-BOOK OF SURGICAL DIAGNOSIS. Edited by A. J. WALTON. In two volumes. Octavo, leatheroid; pp. 534 and 587. Wm. Wood and Co., New York, 1928.

This is a very convenient handbook, owing to its division into two moderate sized volumes, in a form that is easy to handle and consult. It is an interesting example of the present-day tendency to teamwork in writing as well as in practice. This book is the result of the coöperation of thirty-one different authors, each of whom is to be accepted as of established reputation in his special branch of surgery. Such may well be the case for they are drafted for this work from prominent British Hospitals, in fact from seventeen different ones in which are represented not only London but also Birmingham, Manchester, Leeds and Edinburgh. From London itself we recognize the London, Guys, Westminster, Kings College, Middlesex, St. Marks and West London Hospitals. As Mr. Walton, the editor of the combined product, is a London Hospital surgeon, it would be natural that the staff of his hospital should be especially well represented in the list of his co-workers. Such is indeed the case, for of the fifty-two chapters presented by the two volumes, twenty are the work of the staff of that great institution. Seven of these are by Mr. Walton himself. There is one chapter by an American surgeon. We are not surprised to find that when search was being made for an adept in the diagnosis of so complicated and important a subject as Acute Infections of the Hand our confrère of Chicago, Allen B. Kanavel, was chosen. This is a choice the propriety of which American surgeons can understand. It cannot fail to create a good impression among us for the rest of the collaborators. The editor-in-chief says in his preface that there has been a tendency for the knowledge and practice of operative treatment to out-step that of surgical diagnosis. He, therefore, has been prompted to produce a book which in a special degree should deal with the difficulties of diagnosis of surgical lesions in a concise and practical manner. The result of his efforts is this book. It has evidently been thoughtfully planned and well executed. The ideas and methods of men specially skilled in their several departments have been elicited and are here presented. No one will go astray who follows the counsels here contained. It is to be noted as a feature of the book worthy of special commendation that while modern laboratory methods of investigation are given due weight and proper importance, the value and importance of the clinical history and the physical examination of the patient are still emphasized, and their place insisted upon as of prime importance among methods of diagnosis to which other methods should be regarded merely as accessory.

LEWIS S. PILCHER.

BOOK REVIEWS

UROLOGICAL RÖNTGENOLOGY. By HUGH A. YOUNG, M.D., and CHARLES A. WATERS, M.D. 4to., cloth, pages 496. Paul B. Hoeber, New York, 1928.

This book forms the seventh volume of the "Annals of Röntgenology" as edited by James T. Case, M.D. There is no subject in diagnosis in which the X-ray plays such an important part as that of urology, and indeed none in which it is more difficult to evaluate the film findings correctly. This is correctible to a large extent by the experience of the röntgenologist who interprets the films; but, irrespective of the reader's experience, to have for consultation such an atlas of master röntgenograms as this volume affords must prove of importance.

In no field of diagnosis or therapeutic endeavor have more rapid and important strides been made than in the conjoint work of the röntgenologist and the urologist. Primarily the elaboration of the combined cystoscopic-Röntgen-ray table greatly improved the possibilities of this conjoint work, and the introduction of the Bucky diaphragm similarly enhanced the degree of accuracy and more definite delineation of the organs and viscera involved.

The authors, appreciating the importance of the intimate knowledge of each other's problems, have apparently felt it necessary to include a brief but comprehensive outline of the whole subject of urology, rather than simply a röntgenological atlas of the genito-urinary tract, stressing the pathology and gross and minute changes externally and internally which they produce, and also a brief outline of the symptomatology, diagnosis, and therapy of the various conditions considered and depicted. In many instances case histories are succinctly recorded. An interesting and convenient departure is the inclusion of a diagnostic case index whereby the illustrations and case histories are made of much greater value to both departments.

The volume contains 518 illustrations. The radiographic pictures are most excellent and extremely instructive. Emanating as it does from the Brady Institute of Johns Hopkins Hospital it naturally reflects the work done there and stamps it as a most authoritative treatise.

JAMES T. PILCHER.

UROLOGY. By EDWARD L. KEYES, M.D. 8 vo, cloth, pp. 763. D. Appleton & Co., New York, 1928.

The most concise critical statement which can be made concerning this book is to say that it is Keyes'. It represents the views and ideas of its author better than almost any other book that has come to the reviewer's attention. The reader will find characteristic and delightful the animated style and frequent flashes of wit and humor, and the frank use of the first personal pronoun throughout.

The book, therefore, is a free expression of the author's mind and is not highly systematized. The latter feature is compensated by an adequate index. The subject matter represents the largely clinical viewpoint of the author. In his preface he says boldly, "Let us leave pathology to the pathologist", and

BOOK REVIEWS

he has done this. He has also substituted the fruits of a varied and extensive experience for lengthy abstracts of the literature. Procedures and opinions which he has not adopted are dismissed with a word, but, on examining carefully the subject matter, one finds there a measure of the man who writes, for it is sound and filled with common sense.

The reviewer does feel, however, that the reader should realize these characteristics of the book and that, on account of them, understand that it is not a compendium of everything that is known or taught in modern urology, but is the autographic credo of one highly talented urologist. The reviewer feels that the suitable text-book for the student or beginner should be built more on a pathological basis, but no one who has had such a basis can fail to profit from reading this book.

The sanity of the author is particularly seen in his admirable chapter on "Derangement of the Male Genital Functions". Gonorrhœa, exclusive of stricture, has fallen from its former preponderant position and is now confined to sixty-seven pages at the end of the book. This is in line with the modern trend of urology. The mooted question of ureteral stricture is treated in a conservative way which well falls in with the views of most urologists. The illustrations are good and adequate. All of the X-ray pictures have been reproduced as outline drawings, and are surprisingly satisfactory. The last chapter is made up of "maxims" concerning gonorrhœa, which are models of compactness and lay stress, as they should, on the hands and brain of the physician.

DAVID M. DAVIS.

TEXT-BOOK OF UROLOGY. By DANIEL N. EISENDRATH, M.D., and HARRY C. ROLNICK, M.D. 8 vo. Cloth. Pp. 942. J. B. Lippincott Co., Philadelphia, 1928.

This book of Doctors Eisendrath and Rolnick is in striking and interesting contrast with that of Doctor Keyes. This, of course, is as it should be. In the past our urological text-books have been too much alike.

The authors have deliberately set out to write a text-book for students. Without the extensive personal and ancestral background of Doctor Keyes, they are more eclectic, more laborious, and more systematic. For the benefit of the student, the text is beset with words and phrases in dark-face type. This is no doubt of value for quick reference, but the reviewer doubts that it will help the earnest reader. The literary style leaves something to be desired, and the English is not always above criticism.

One hundred seventy pages are devoted to a very thorough consideration of equipment and technic. This leaves 628 pages for pathological and clinical description and 114 pages for the operative manual. The indexing has been very thoroughly done. Symptoms and diagnosis are completely covered, but the reviewer would like to see more pathology. Some of the sections on treat-

BOOK REVIEWS

ment are admirable, but others are so brief that they leave the inexperienced in doubt as to how to proceed in a given case.

At a very few points the eclecticism of the authors fails. Three examples suffice. They do not like the Kollman dilator, they think indigo-carmin will supplant phenolsulphonephthalein as a functional test for cystoscopic work, and they recommend without reservation the syringe method for pyelography. They may be quite right, but the student should be acquainted with other views on these matters. The chapter on Sexual Neuroses by Doctor Koll is orthodox. The reviewer thinks that more emphasis will have to be laid on the psychotic aspects of these disorders.

The text is very well documented, and there is no doubt that the generous provision of references to the literature is beneficial to the student. This feature deserves wide imitation. Stricture of the ureter is given a wise and sane interpretation. Doctor Eisendrath's interest in congenital anomalies, especially of the kidney and its circulation, has made these sections strikingly excellent. The illustrations are abundant and very good. They go to new lengths in utilizing the visual method for inculcating fundamentals.

The authors are to be congratulated on producing *de novo* such an excellent book. It is a mine of information.

DAVID M. DAVIS.

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